Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

OCTOBER, 1949

TECHNOLOGY DEPT.

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BLOOMING MILLS

. . . designed and built by

Color Photo by E. D. MESTA

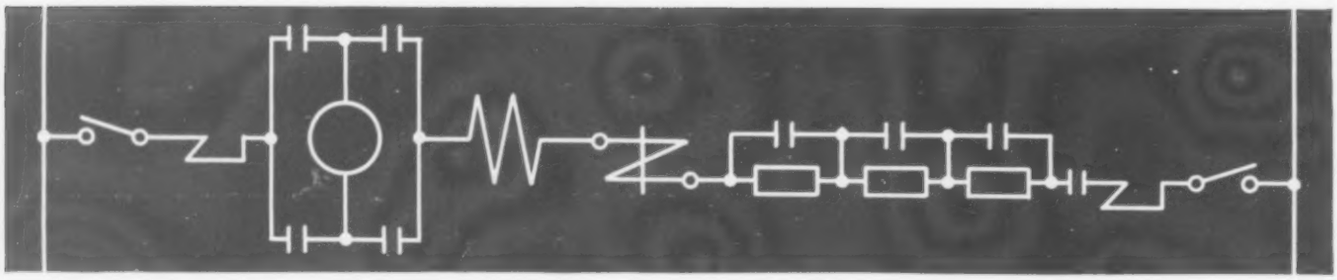
Designed and built by Mesta in 1919, this 44" Blooming Mill, installed at the Aliquippa Works of the Jones & Laughlin Steel Corporation, rolled a record monthly tonnage in its thirtieth year of service.

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

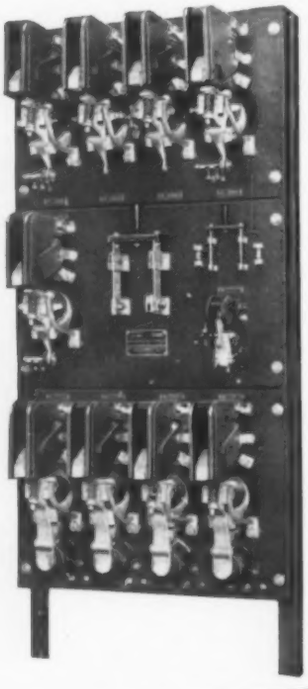
MESTA MACHINE COMPANY · PITTSBURGH, PA.

What control for what mill equipment? One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it *the* preferred control for the steel industry.

D. C. reversing plugging control



When you have an installation such as a reversing table, where load and performance characteristics dictate the use of a series wound motor which must be frequently and rapidly reversed. . . .



Then . . . call for Cutler-Hammer Control No. 14010

Cutler-Hammer Bulletin No. 14010 offers the following advantages:

ACCELERATION.... Cutler-Hammer Inductive Time Limit Control, a pioneering development of this company, accelerates all loads alike, smoothly, safely, uniformly. The simplest accelerating system, eliminating relays, dashpots and other parts that commonly give trouble.

PLUGGING PROTECTION.... gained without the need of auxiliary relays, typical of the simplicity of Cutler-Hammer design.

EQUIPMENT.... Conforming to NEMA standards. Available in ratings up to 1800 amperes. In open, enclosed or complete factory assembled ready to wire units. A complete line of control accessories.

USERS PREFER CUTLER-HAMMER CONTROL because they know Cutler-Hammer as the oldest in control specialization, pioneering such important achievements in steel mill practice as crane control, ore bridge control, inductive time limit control, etc. In fact the control for the first electrically driven mill was . . . Cutler-Hammer Control.

They know too from personal experience that C-H control is not stinted in any of its parts, that in every detail Cutler-Hammer control is *engineered* control, *by* engineers *for* engineers.

Finally, users have found constant betterment, constant improvement. Quality has never slipped back, has never long stood still, has always moved forward.

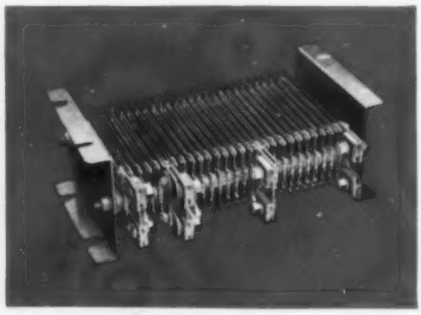
These are some of the reasons why so many men in steel say: "Give me C-H control every time." CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Typical Components of Cutler-Hammer Mill Control

Mill Contactor
The mill-type contactors whose reliability, life and low maintenance have made them the standard for the industry.

Mill-Master (Cover removed)
Compact construction with cam-operated twin break contacts. Preferred because of its ease of operation.



Dur-Ristor
The durable, unbreakable mill duty resistor with the single, continuous strip resistor element of tough alloy.

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania under Act of Congress March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 26, No. 10.

ANOTHER ADVANCEMENT

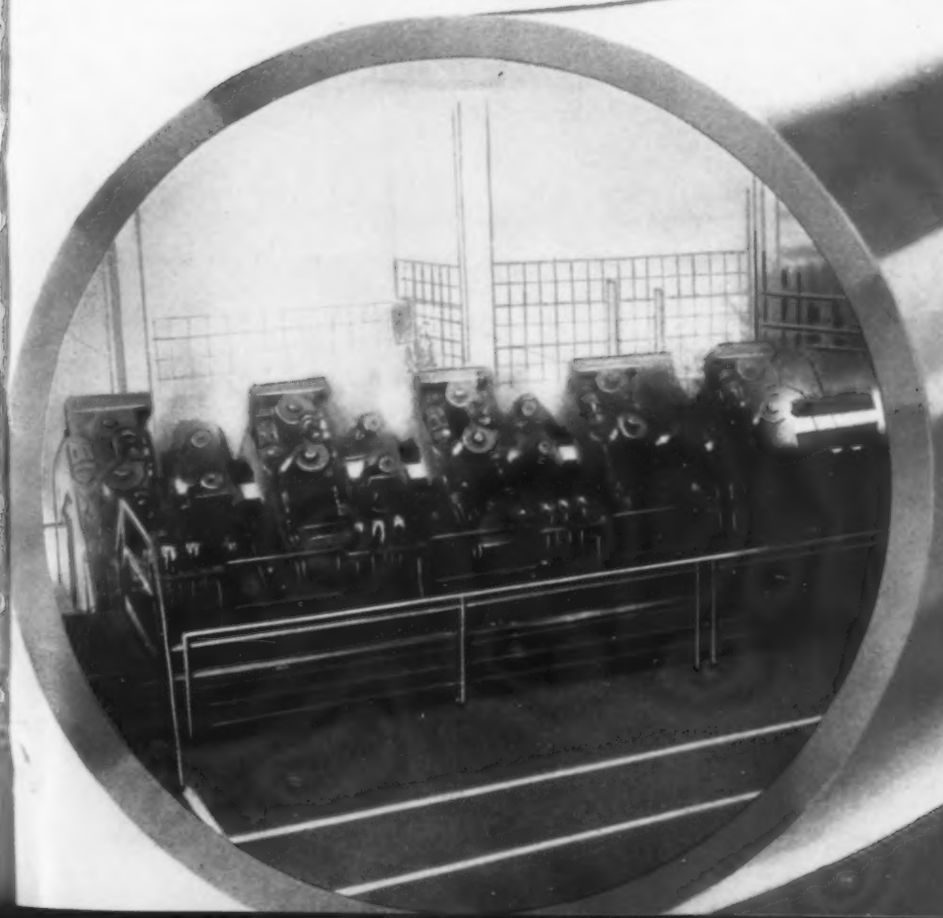
in seamless pipe mills

This continuous seamless pipe mill, based on the stretch-reducing principle, has been hailed as "one of the greatest advances in the steel industry during the past 50 years." National Tube and Aetna-Standard specialists have been working together for several years in the development of this world's first continuous seamless pipe mill now in operation at Lorain. Aetna-Standard builds most of the seamless tube mills in the world, for pipe sizes from 2¼" to 26". Most of the technological advancements have come from the combined efforts of this company and the practical realists of the industry.

THE AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES:

HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
AETNA-STANDARD ENGINEERING COMPANY, LTD., TORONTO, ONTARIO, CANADA



WHY *National Rolls*

give you durable, dependable performance on the stands

Experience

The intricate problems of casting superior rolls can only be mastered through experience. For more than forty years we have been supplying to leading fabricators all types of rolls for metal rolling and forming.

Laboratory Control

Experienced personnel in National's laboratories maintain constant supervision over every step of production beginning with raw material analysis to rigid inspection of the finished roll . . . and the laboratories carry on continuous research into new and better materials and methods, which is reflected in National's strong, durable rolls.

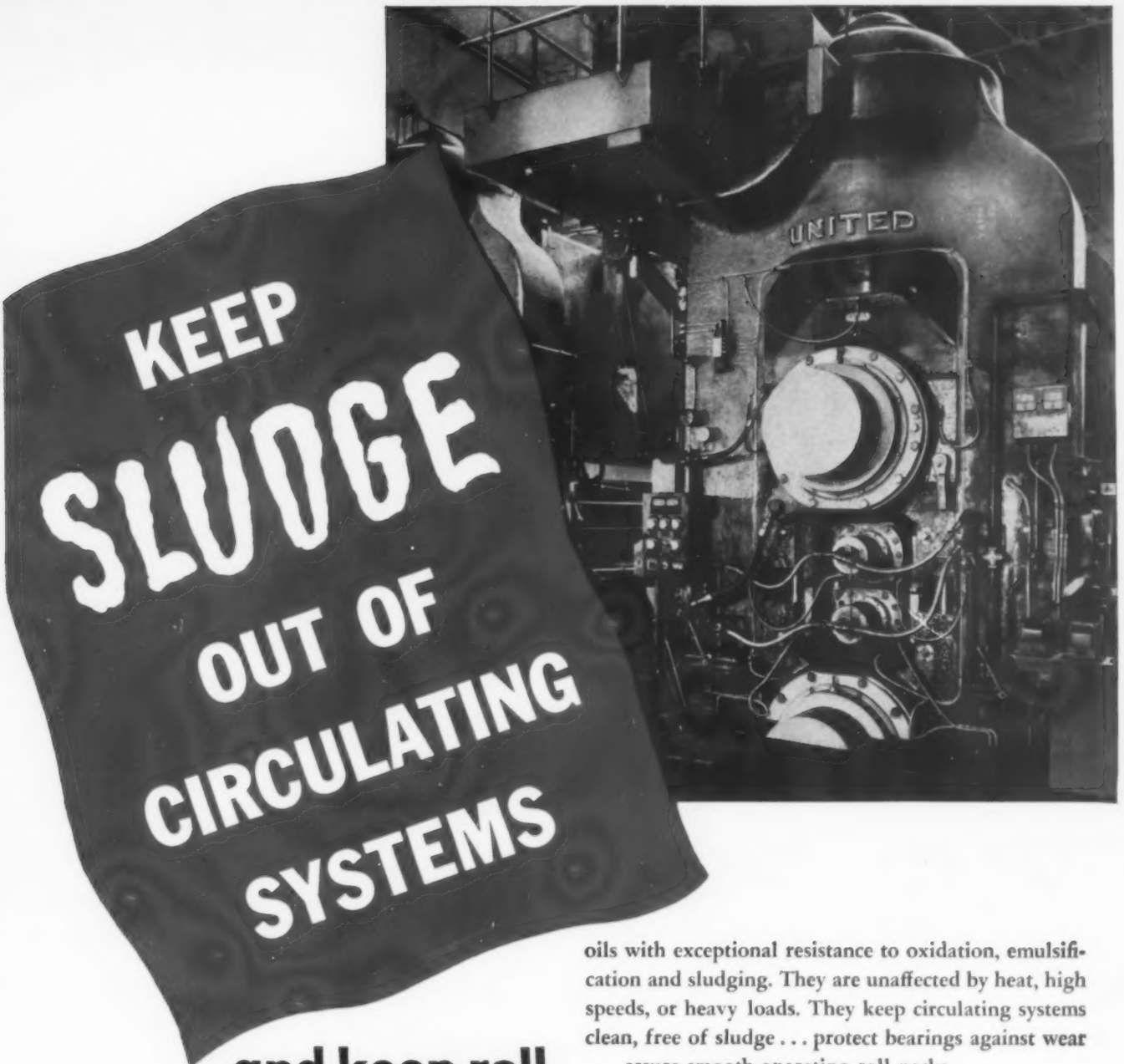
Metallurgical Skill

To meet individual requirements for hardness, heat-resistance, composition, National's metallurgical staff is constantly alert during every phase of production to see that the right ingredients in the right amounts are mixed to assure you flawless rolls.

Precision

To precision-finish rolls to the closest tolerance, National uses the most modern machine tool equipment. This equipment in the hands of National's machinists is your assurance of rolls precision-finished to your exact specifications.

THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA
Specialists in Iron and Alloy Iron Rolls



...and keep roll necks rolling by using Texaco Regal Oils

When you charge your circulating systems with *Texaco Regal Oils,* you have the best assurance of smooth, trouble-free operation . . . faster production . . . longer life for oil film roll necks . . . minimum maintenance costs.

Texaco Regal Oils are turbine-quality heavy-duty oils with exceptional resistance to oxidation, emulsification and sludging. They are unaffected by heat, high speeds, or heavy loads. They keep circulating systems clean, free of sludge . . . protect bearings against wear . . . assure smooth-operating roll necks.

To prolong the life of enclosed reduction gears and bearings in heavy-duty service, use *Texaco Meropa Lubricants.* They resist oxidation, thickening and foaming . . . have effective extreme pressure characteristics . . . provide constant protection against wear.

Use Texaco Products and Lubrication Engineering Service to increase efficiency and economy throughout your plant. Call the nearest of the more than 2300 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Regal Oils

(HEAVY CIRCULATING OILS)

BIG CRANES

For fifty years, The Alliance Machine Company has been a leader in the designing, engineering and building of giant cranes for heavy industry. Many safety and mechanical features now accepted as standard practice in steel mill cranes, were first introduced by Alliance. In open hearth cranes, these features include interlocked drums, synchronized worm drive, 4-girder bridge construction, safety rope reeving and laminated ladle hooks. For increased safety, these hooks are equipped with universal joints at the top, permitting them to swing freely in any direction, thus preventing the hooks from bending and shearing rivets due to accidental collision.

The Alliance Machine Company has designed and built thousands of big cranes of all types to move heavy loads safely and economically. Give us an opportunity to solve your crane problems.

THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO · PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES
STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH
CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

Would You Like 100 Tireless Hand·Chippers For Your Billet·Shed?

IT'S A MAN·KILLING JOB . . .

LET THE BILLETEER DO IT...

One hand chipper can remove a 12" chip in 60 seconds of ear-splitting, grueling work, whereas . . .

A Bonnot Billeteer operator removes a 12" chip in 2 seconds, as the 45-ton machine responds to his finger-tip control. Electric and hydraulic power activates the carriage, roll-table, chucking, turn-over, feed and turnout units. There's practically NO OPERATOR FATIGUE—no let-up in the steady output.

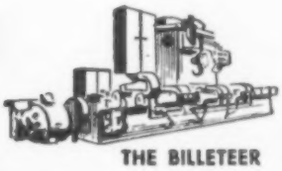
Safety-wise, a recent survey revealed that in 490,000 Billeteer hours of operation, only one man was involved in a disabling accident—A TRULY-TERRIFIC BILLET-SHED SAFETY RECORD.

MEN LIKE TO OPERATE BONNOT BILLETEERS. They decrease employee turnover in your billet-shed and boost efficiency and output.

Write today for complete information. A Bonnot engineer will give your inquiry his personal attention.

Engineered for Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

ALSO MANUFACTURERS OF SAWING • CRUSHING • PULVERIZING & MIXING EQUIPMENT
BILLET INSPECTION TABLES • DUST PUG MILLS • SINTER PLANT PUG MILLS

The 2 largest Pyramids could be made from Billets Rolled last year . . .

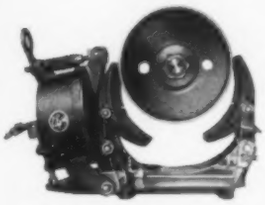
THE TONNAGE of steel billets produced last year was about equal in volume to the two largest pyramids in the world. Together these two cover more than 24 acres of ground and rise to heights of 480 feet. Much of this tremendous tonnage was rolled on mills using rolls made by Pittsburgh Rolls with the familiar P.R.W. mark on the end of the wabbler.

Rolls with this mark have acquired a long-standing reputation for high tonnage and inherently longer life. Their performance can be expressed in few words: *less cost per ton of steel rolled.*

PITTSBURGH ROLLS • Division of Blaw-Knox Company • Pittsburgh 1, Pa.

PITTSBURGH ROLLS

Complete Control for Cranes



LONG-LIFE Brakes give high speed performance—with low up-keep.

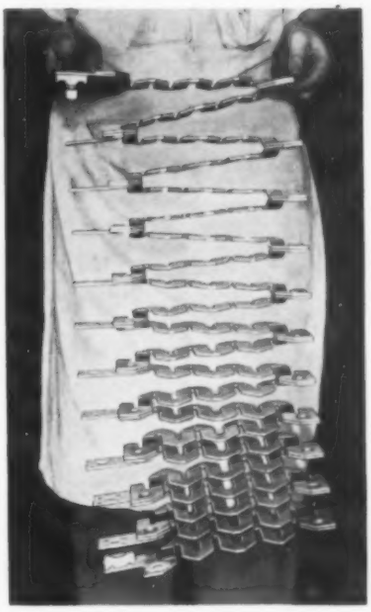
SHORT-THROW narrow width Cam Master switches are easy on the operator.

TIME - CURRENT Relay matches acceleration to the d-c load.

YOUNGSTOWN Safety Limit Stop — a positive check against human error.

HOW EC&M *TAB WELD* PLATE RESISTORS

1. Save Manpower
2. Cut Costs



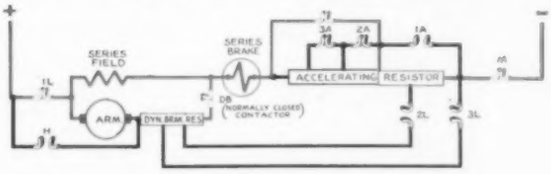
EC&M TAB-WELD Plate Resistors are designed to reduce maintenance costs by a new construction which has shown excellent operating results.

This construction brings grid-eyes into intimate contact, eliminating the electrical connectors previously required between grids. Spot-welding the tab-ends of the grids maintains the intimate contact and provides a continuous electrical path without depending on the pressure of the end-clamping nuts.

Other features of merit are:—convenient tap-plates for adjusting the resistance for the desired motor operation, quick replacement of sections, metal tap-plate identification tags, etc. Write for Bulletin 942 giving complete details.

Stabilized resistance-value } ***with EC&M***
Elimination of trouble in concealed areas } ***TAB-WELD Resistors***

SIMPLIFIED Safe Dynamic Lowering Hoist Control.



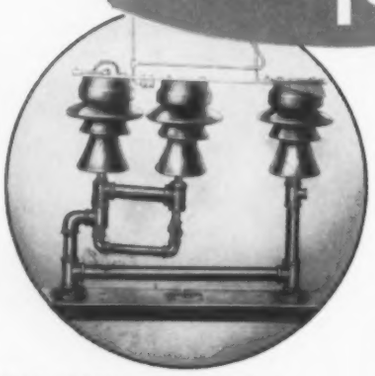
CRANE DISCONNECT SWITCH Manual-magnetic for ease of operation.

THE ELECTRIC CONTROLLER & MFG. CO.

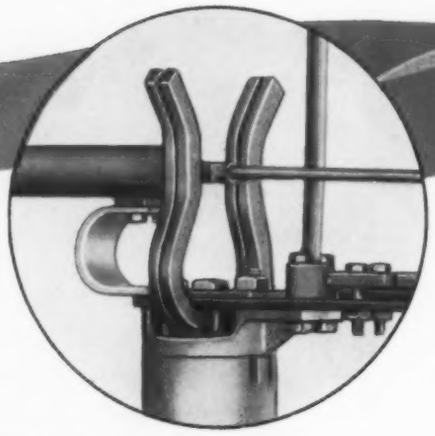
2698 EAST 79TH STREET ★ CLEVELAND 4, OHIO

R&IE *AGAIN* Makes History with the MODERN

1910 1922



1910—R&IE introduced the "Burke" switch—the forerunner of today's outdoor switching equipment



1922—R&IE introduced the Hi-Pressure contact, an important improvement in switch design

CHECK the 1949 FACTS

1 JAW CONTACT—Hi-Pressure, Hi-Thermal capacity silver to copper contact. ONLY ONE BREAK CONTACT on the switch. Copper and beryllium jaw—copper for thermal capacity and beryllium for strength and resilience. Here's maximum protection against fault current damage.

2 HINGE CONTACT—Completely enclosed and weather sealed Hi-Pressure, Hi-Thermal capacity, silver to copper Hinge Contact. Continuous, annular, constant electrical and mechanical contact at all times. Eliminates second break contact with its multiplied problems and maintenance.

3 BLADE OPERATING MECHANISM—Simplified and "streamlined" to attain a simple harmonic, accurately controlled blade motion. Special pin fastenings, snap rings, and rivets have been eliminated from moving parts. Universal blade balance on 69 Kv. and above.

4 BLADE—Extra heavy, hard drawn tubular copper with integral, formed contact end. Solid current path from jaw to hinge contact.

5 TERMINALS—Four half-inch bolts on 1¾ x 1¾ inch centers permit NEMA standard 600 or 1200 Ampere clamping and R&IE Type "UC" universal clamps. Both terminals equal height from base.

6 BEARING—Aluminum housed, weather sealed, stainless ball—requires no lubrication.

THE SWITCH DESIGNED

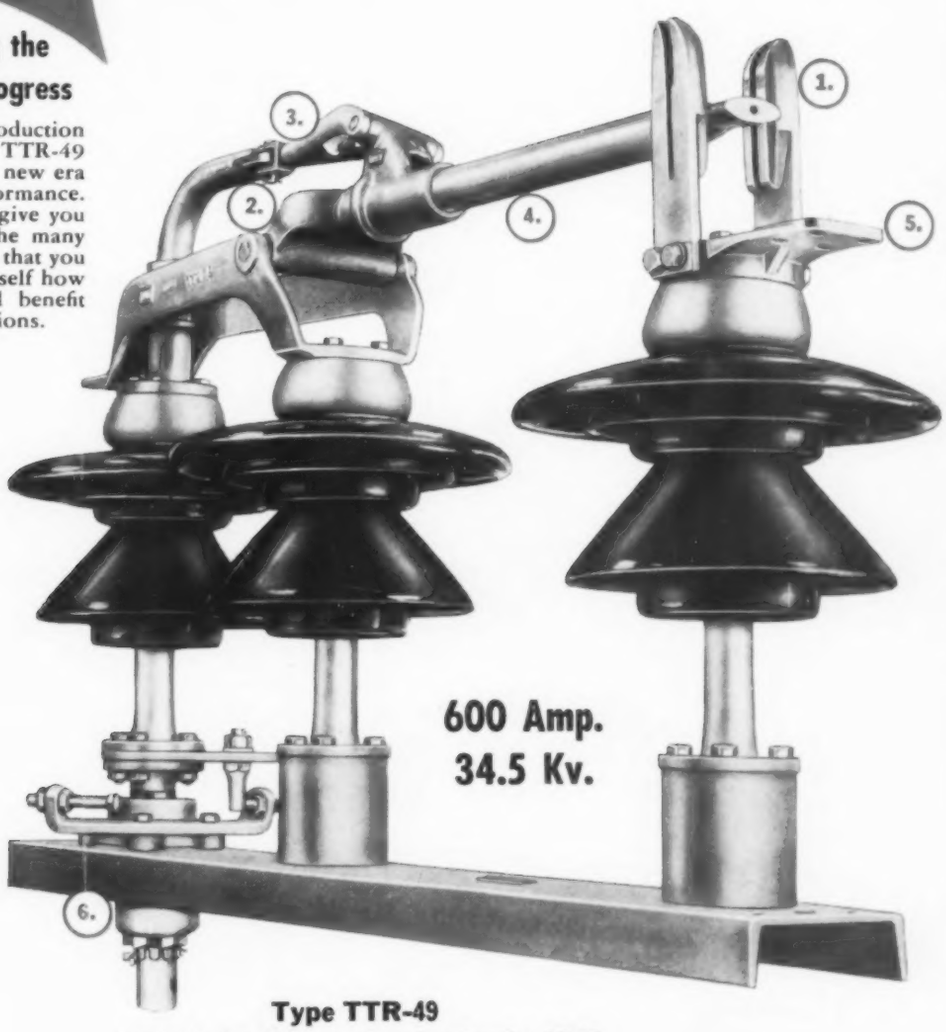
PIONEER

The NEW Type TTR-49 Disconnecting Switch with Sealed Pressure Hinge Contact

1949

Continuing the March of Progress

In 1949, the introduction of the R&IE type TTR-49 Switch begins a new era of switch performance. We will gladly give you full details of the many new features, so that you can see for yourself how its use will benefit your operations.



Type TTR-49

Available for delivery after October 1st, 1949

RAILWAY and INDUSTRIAL ENGINEERING CO., GREENSBURG, PA.

IN CANADA—EASTERN POWER DEVICES LIMITED, TORONTO

An I-T-E ORGANIZATION

R&IE

39 Years of Switch Progress

Built for Outstandin Performanc for the Years to come

WITH YOUR OPERATING PROBLEMS IN MIND

New... HIGH SPEED BIG TONNAGE *'Surface'*

★AT WEIRTON STEEL COMPANY... each 'Surface' Annealing Cover provides capacity for 20 giant coils of light gauge steel for tin plate and zinc coated materials... each coil containing a single strip that is 5 miles long and weighing about 15 tons.

A combination of many outstanding 'Surface' developments and improvements makes this most recent 'Surface' Annealing Cover installation a unique operation providing maximum efficiency, economy and fast, quality production. Equipment includes 12 bases, 4 radiant tube heated covers, and 2 NX Gas generating units, each with a capacity to produce 20,000 cu. ft. hr. of nitrogen gas.

Coils up to 66-in. O. D. with a 16½-in. I. D. can be annealed, effecting many mill economies such as minimum shut-downs for rethreading. Large coils means reduced handling costs all along the production line.

High Speed and Big Tonnage are augmented by *top quality control* . . . making possible a product that is definitely improved for electrolytic tin-plating or other coating.

From Ingot to Finished Products, 'Surface' has pioneered in equipment for the steel industry including modern One-Way Fired Soaking Pits; Slab, Billet and Bloom Heating Furnaces; Continuous and Batch Normalizers and Annealers; Muffle and Radiant Tube Fired, Controlled Atmosphere Furnaces, and many other types of heating and heat treating equipment.

Ask 'Surface' Engineers for up-to-the-minute recommendations on equipment needs *wherever heat is used in the steel industry.*

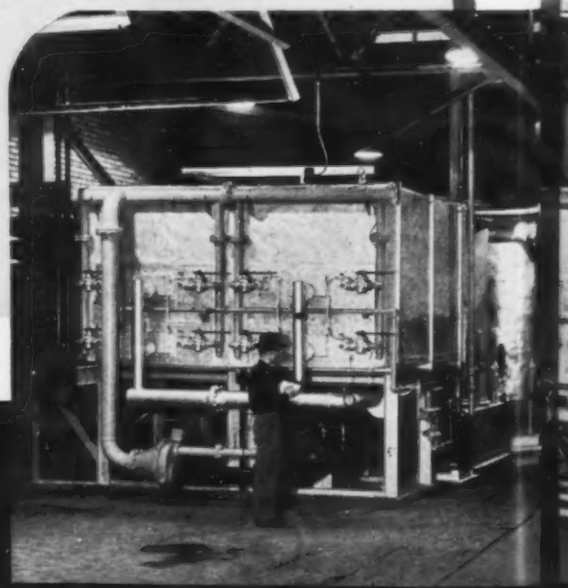
DEVELOPMENTS AND IMPROVEMENTS

MAKE POSSIBLE SPEED AND UNIFORMITY OF STRIP COIL ANNEALING

1. **Coil Separator**—Of simple, rugged construction for balanced convection heating and cooling. Directs rapidly circulated heating and cooling gases to the ends of the coil laminations thereby utilizing solid metal heat transfer, rather than conduction through laminations.
2. **High Powered Base Fan**—'Surface' design. Power input ten times greater than used formerly. Incorporates a unique method of sealing annealing atmospheres against differential pressures.
3. **Corrugated Inner Cover**—Deep corrugations absorb and transfer the heat to the circulated gases within the inner cover during the heating cycle and speed cooling of the charge by reason of the large area exposed.
4. **Radiant Tube Heating Cover**—Stepped-up useful heat input of 'Surface' Radiant Tubes balance the fast heat absorption rate of the new deep-corrugated inner covers and fast heat transfer of base fans and coil separators.

. . . and for Quality Control

5. **NX Annealing Atmosphere Generator**—Furnishes a gas atmosphere environment for the steel, producing the highest quality electrolytic tin plate. Tin plate annealed in 'Surface' NX Gas Atmosphere shows high corrosion resistance, more uniform plating, and fewer plating defects.

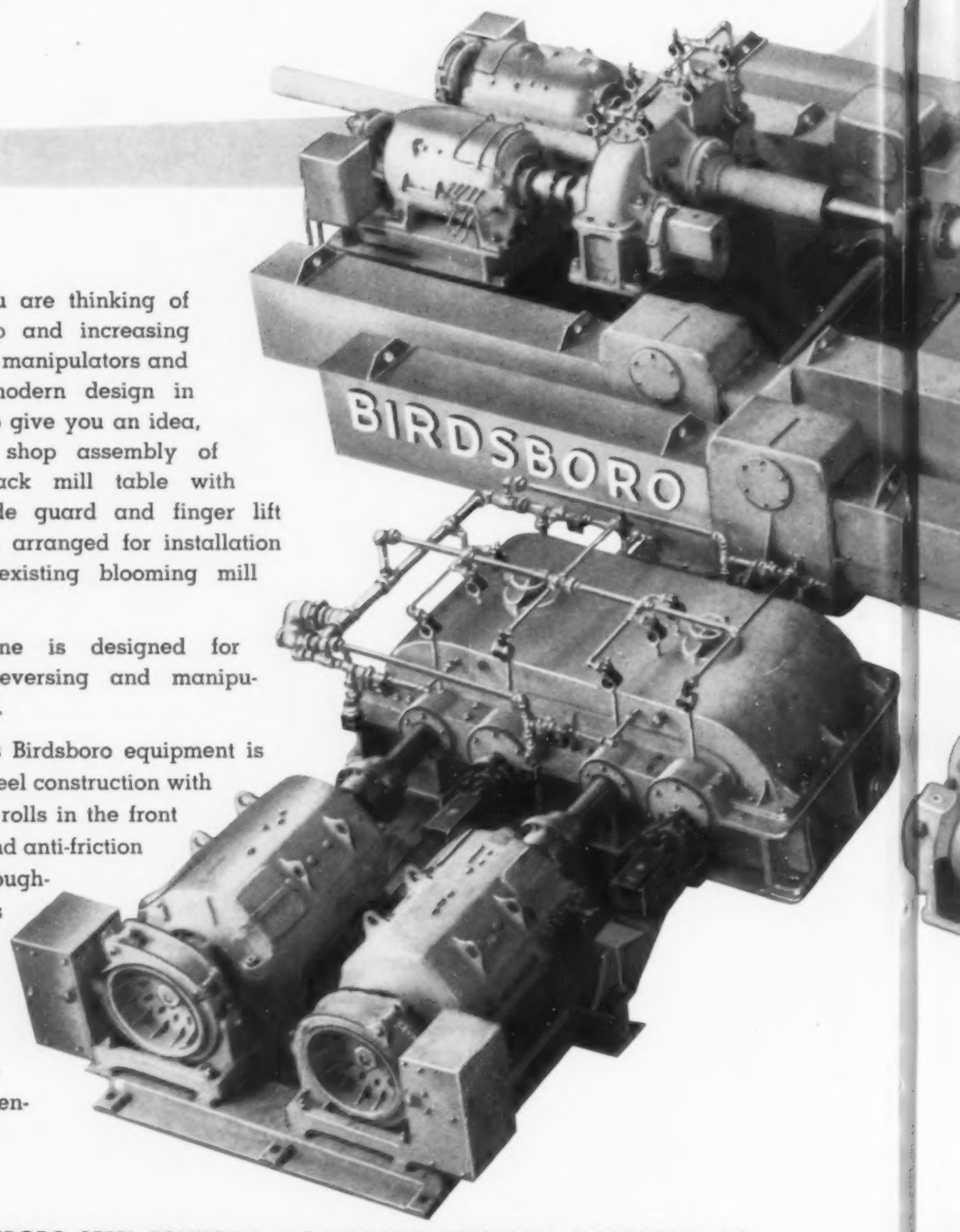


SURFACE COMBUSTION CORPORATION
TOLEDO 1, OHIO

FOREIGN AFFILIATE COMPANIES
BRITISH FURNACES LIMITED — CHESTERFIELD
STEIN & ATKINSON, LTD. — LONDON
STEIN & ROUBAIX — PARIS, LIEGE AND GENOA
WILL L. SMITH S. A. — BUENOS AIRES

COIL ANNEALERS •
feature
BALANCED
HEAT FLOW
4
1
2
3
5

speed up ROLLING MILL OPERATION



• When you are thinking of speeding up and increasing output, keep manipulators and tables of modern design in mind. Just to give you an idea, here is a shop assembly of front or back mill table with movable side guard and finger lift manipulator, arranged for installation with your existing blooming mill equipment.

This machine is designed for maximum reversing and manipulating speed.

Because this Birdsboro equipment is built of all-steel construction with forged steel rolls in the front of the mill and anti-friction bearings throughout, it stands up under the most severe service with minimum maintenance.

BIRDSBORO STEEL FOUNDRY and MACHINE COMPANY, BIRDSBORO, PA.
OFFICES IN: BIRDSBORO, PA. and PITTSBURGH, PA.

REPRESENTATIVES AT:

9925 S. Hamilton Ave., Chicago 43, Ill.

507 Terminal Tower Bldg., Cleveland 13, Ohio

with this modern

BIRDSBORO MANIPULATOR & TABLE

This is another example of Birdsboro's advanced engineering—a service we invite you to call on at any time to help you solve any steel mill equipment problem.

BIRDSBORO

STEEL MILL EQUIPMENT

DESIGNERS and BUILDERS OF: STEEL MILL MACHINERY • HYDRAULIC PRESSES ROLLS • SPECIAL MACHINERY • STEEL CASTINGS

high-speed rod and merchant mill uses amplidyne control -to help roll a wider variety of products!

Shown in this merchant-mill motor room are 6 of 13 G-E main-drive motors, rated 100 to 800 hp. The 4000-kw motor-generator set in the rear is driven by a 5600-hp, 514-rpm synchronous motor.

General Electric-engineered drive provides simple, flexible operation—helps roll more steel!

Add this as another example of steel mill drives equipped and co-ordinated by General Electric for modern, high-speed operation. It's the main drive recently installed in a large midwestern rod and merchant mill to roll billets into shaped steel products.

Accurate Speed Adjustment!

Driving its 15 stands are 13 main-drive motors in two groups. Each group is powered by a separate generator, with its voltage separately controlled by an amplidyne exciter. By providing a speed differential between groups of motors, a greater variety of products can be rolled.

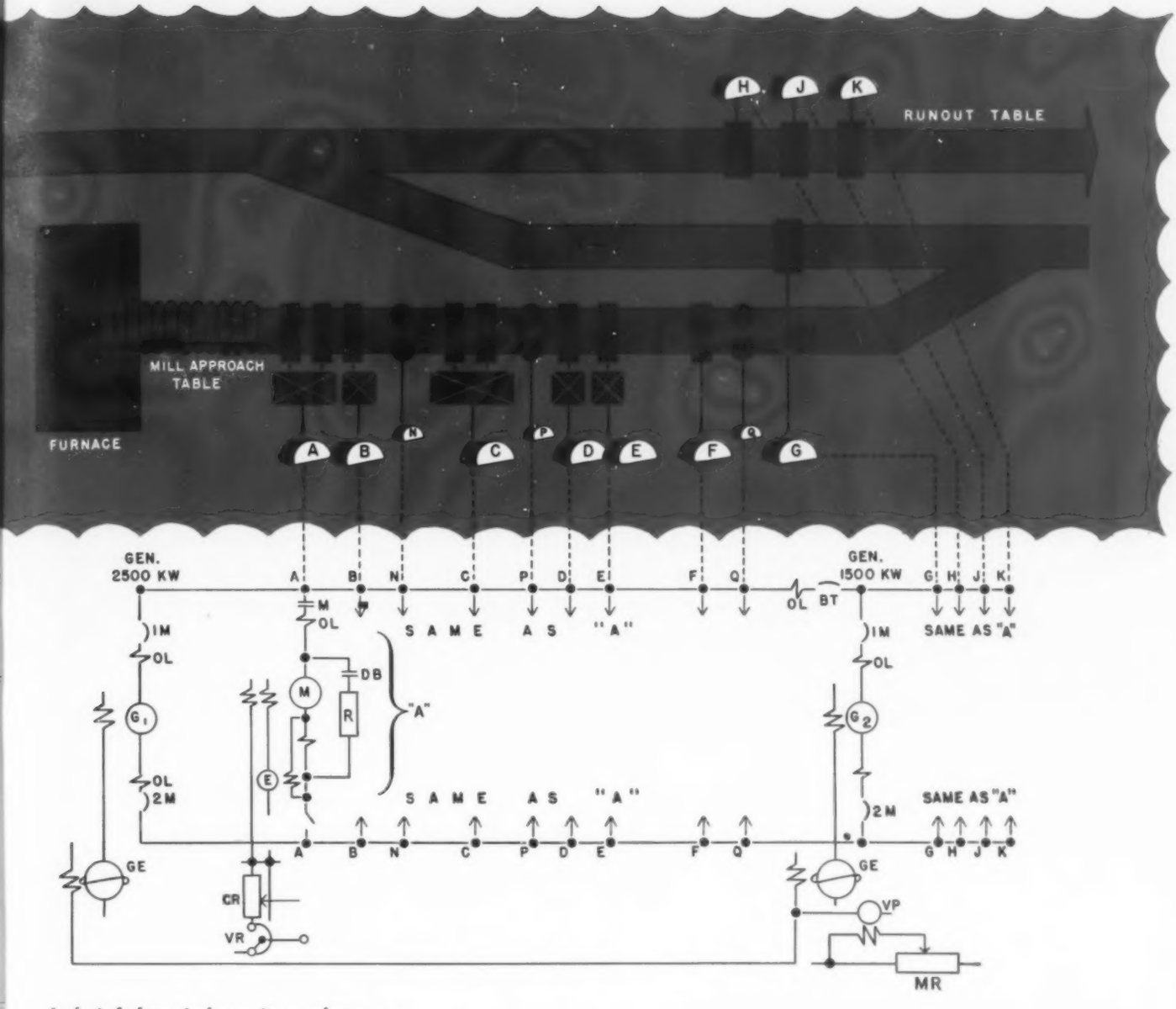
Close Speed Regulation!

In addition, special characteristics built into the main-drive motors maintain a close, steady-state speed regulation, and minimize speed changes in each stand under sudden load changes. Thus, without speed regulators or electronic circuits, this drive provides simple fingertip control, requires less maintenance, helps roll more tons of good steel.

This installation—which also includes complete electric equipment for many auxiliaries—illustrates an important point: To serve the steel industry, General Electric couples experienced engineering skill with extensive manufacturing facilities. That's why you save time, trouble, and expense on drive problems when a G-E steel-mill specialist works with your technical staff. Why not call him at your nearest G-E office? ***Apparatus Dept., General Electric Company, Schenectady 5, New York.***

GENERAL ELECTRIC

559-60



In brief, here's how it works—

In the control circuit shown, the 13 main-drive motors (A thru K) are connected to two generator bus sections—one bus section being supplied with power by a 2500 kw—600 V generator (G1); the other being supplied with power by a 1500 kw—600 V generator (G2). The two generators may be operated at different voltages when the products being rolled require more than normal speed differential between the two groups of motors, or operated in parallel at the same voltage if schedules permit.

Voltages of both generators are automatically regulated to a predetermined value by the amplidyne generator exciters (G-E). The voltage is determined by the motor-operated rheostat in the field of the voltage pilot (VP).

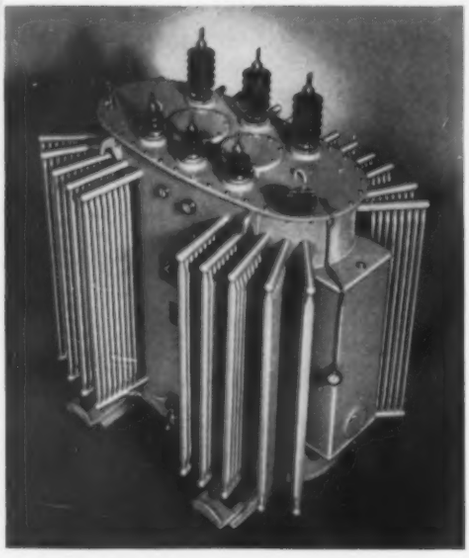
The main shunt field of each stand motor is controlled by a motor-operated coarse-adjusting rheostat (CR) and a hand-operated vernier rheostat (VR). The auxiliary shunt field of each is excited by a series exciter (E) which measures the motor-load current and excites the motor auxiliary shunt field to maintain a steady-state speed regulation of not over 1½% at full load and full voltage.

Special transient-speed characteristics are built into the main stand motors (A thru K) to minimize the change in speed of each stand as the load suddenly changes.

another example of GENERAL ELECTRIC drive engineering at work!

If you are interested in saving money, find out about

Pennsylvania STANDARD PARTS POWER TRANSFORMERS



The use of standard designs and parts shorten engineering and production time to give you lower prices and faster deliveries.

That's right! The economies we realize in manufacturing Standard Parts Power Transformers are passed on to you in the form of lower prices (prices are 4% to 6% less than conventional transformers) and faster deliveries. Pennsylvania Standard Parts Power Transformers permit limited variations, both in parts and in electrical characteristics, to meet a wider range of system requirements. It will pay you to look into this line of Power Transformers which provides the desirable features of custom built transformers at quantity production prices.

Auxiliary compartments, welded to each end of the transformer and connected to each other and to the main tank, form the following oil preservation systems:

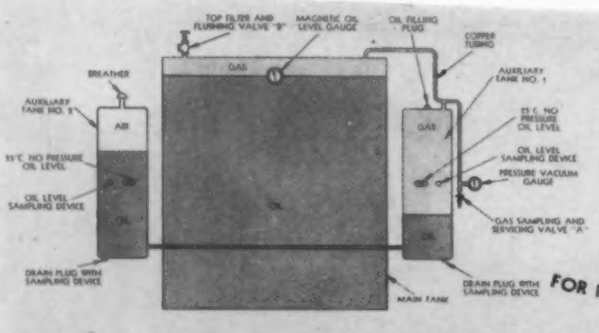
Inert Gas-Oil Seal

Sealed Tank

Inert Gas Pressure System

All Standard Parts Power Transformer tanks, regardless of the type of oil preservation, are filled with the same quantity of oil, with the extra gas and oil spaces provided in the auxiliary tanks. Bushings with standard length shanks are used on all Standard Parts Transformers, and no special-size bushings need be stocked. This permits the user to change the method of oil preservation from Sealed Tank to Inert Gas-Oil Seal; and from Inert Gas Pressure System to Inert Gas-Oil Seal or Sealed Tank.

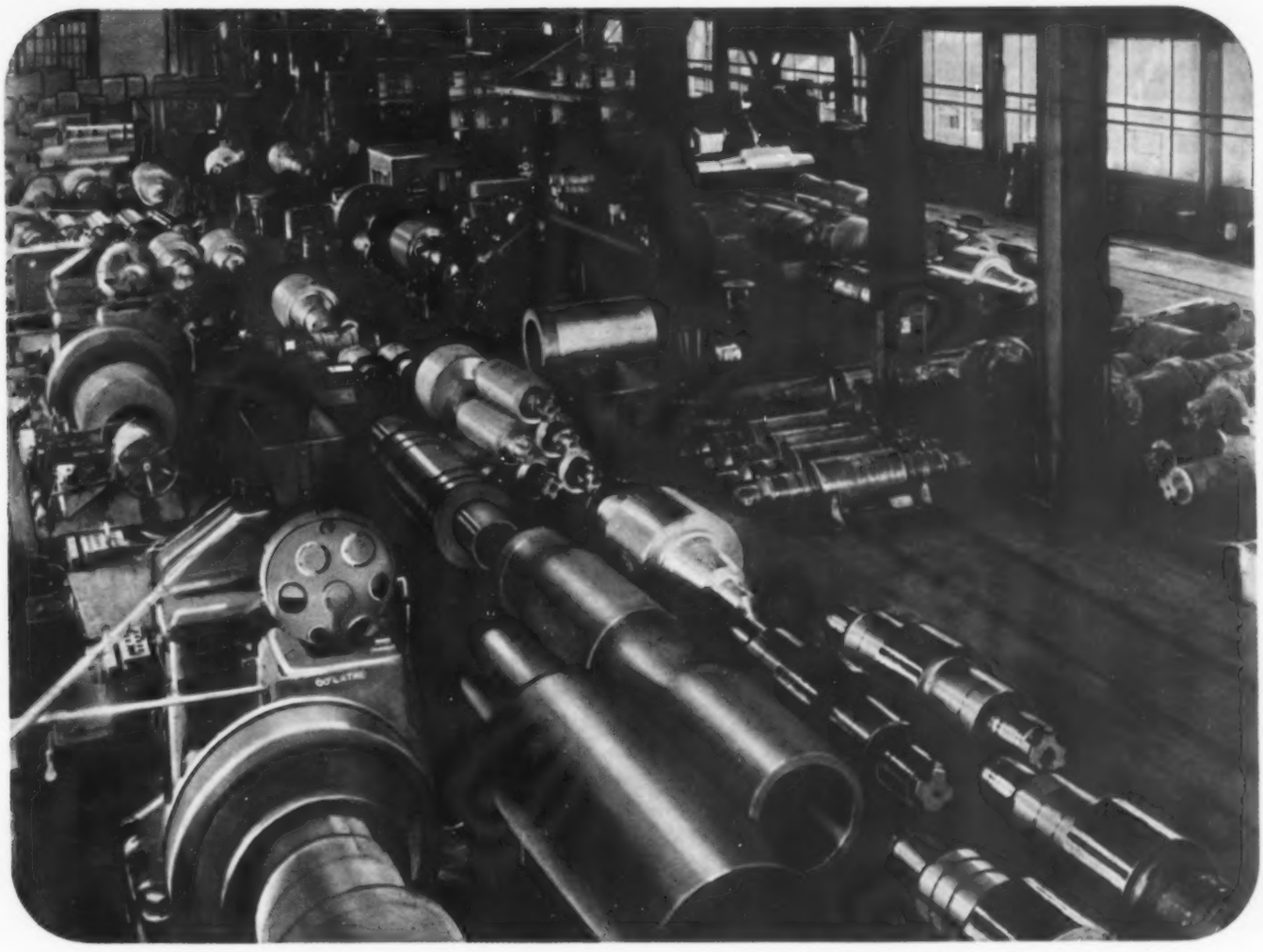
PREFERRED VOLTAGES AND BAND OF RATED VOLTAGES	
PREFERRED HIGH VOLTAGES	RANGE OF RATED HIGH VOLTAGES LINE TO LINE
2400	.....
4800	.....
6900	6600 to 9050
7200	
12000	
13200	11000 to 14750
13800	
22900	21500 to 24600
26400	26400 to 36200
34400	
43800	42000 to 46000
67000	63000 to 69000



DIAGRAMMATIC DRAWING OF INERT GAS-OIL SEAL SYSTEM

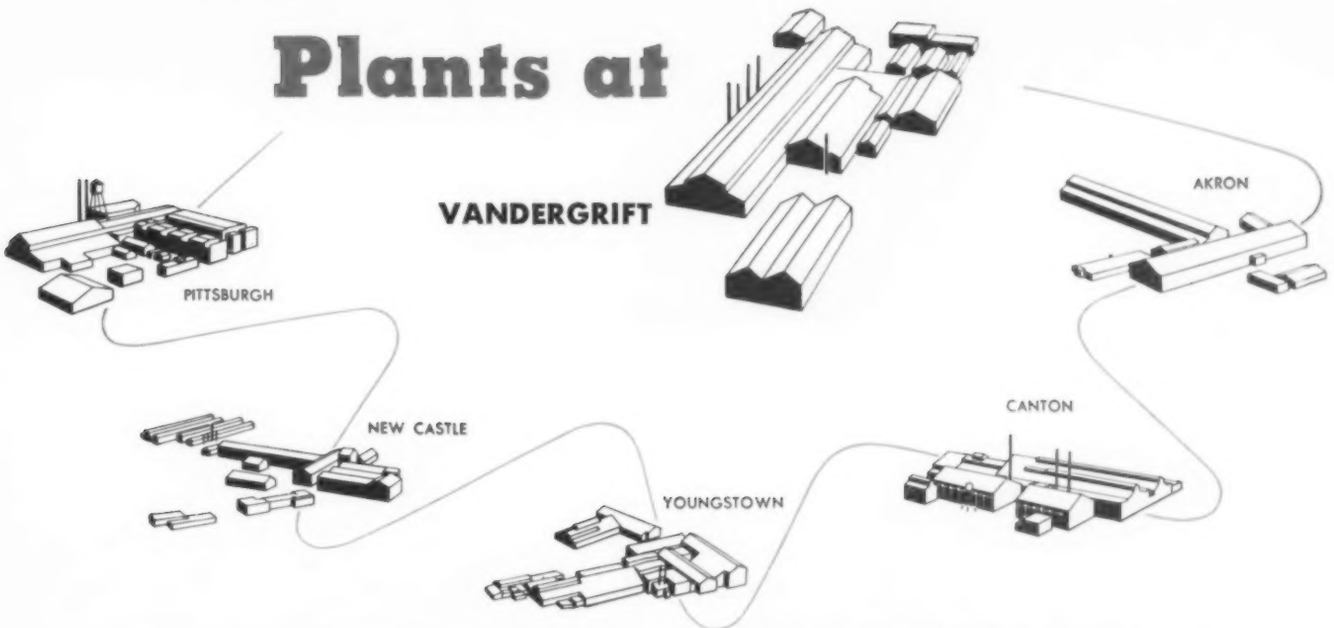
Pennsylvania
TRANSFORMER COMPANY
PITTSBURGH 12, PENNSYLVANIA

FOR FURTHER INFORMATION Pennsylvania TRANSFORMERS WRITE FOR BOOKLET NO. 1498



Section of Roll Plant . . . Vandergrift, Pa.

Plants at



UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Subsidiary: Adamson United Company, Akron, Ohio.

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Designers and Makers of Rolls and Rolling Mill Equipment

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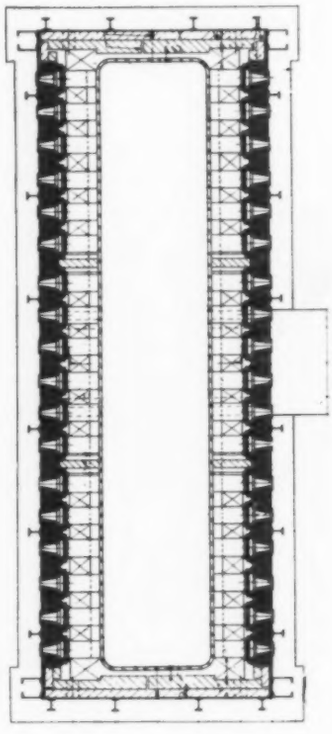
Increases Kettle Life . . .

You can increase kettle life up to three times its ordinary life by having F.E.I. rebuild your galvanizing furnace settings. This patented setting, proved in many installations, also increases ease of operation because of its automatic controls, and only minor repairs may be needed after burnout.

In one large pipe galvanizing plant, the new F.E.I. setting increased kettle life from 20,000 to 70,000 tons. In another plant, kettle life was increased from 12,000 to 36,000 tons. During these runs no repairs whatever were required and fuel consumption was markedly reduced because the setting allows for minimum fuel during idling periods.



Top view of F.E.I. galvanizing furnace burner setting.

F.E.I. offers you a complete galvanizing installation package from original planning through all phases to successful operation. You'll increase production and cut costs when you use F.E.I. method. Write today for full details without obligation.

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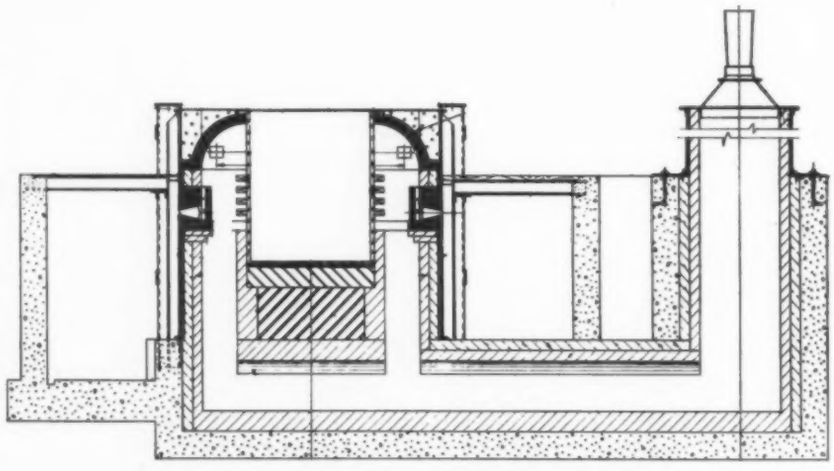
Open Hearth Furnaces; Soaking Pits; Continuous Bloom, Billet and Slab Heating Furnaces; Direct Fired Cover Furnaces for sheet and coil annealing; Salt Descaling Furnaces for stainless steel sheet, bar and other products; Heat Treating Furnaces for every use; Galvanizing Furnaces for tubes, sheet and metalware.



Cross section view of F.E.I. galvanizing installation.

U. S. Patents 2,403,431 and 2,446,642

FURNACE ENGINEERS, INC.

1552 WEST LIBERTY AVENUE PITTSBURGH 26, PENNSYLVANIA

A-B-K Laminated Plastic Bearings

Cut Costs 4 Ways

A-B-K roller neck bearing with separate collar.

A-B-K patented reinforced edge slipper bearing, made to specified blueprint sizes.

Phantom view of A-B-K reinforced edge slipper bearing.

1. Outwear Metallic Bearings
2. Reduce Power Consumption
3. Eliminate Lubricating Oil
4. Require Fewer Adjustments

Steel mill records clearly prove that when metallic bearings are replaced with A-B-K Laminated Plastic Bearings, production goes *up* and costs come *down*. Specifically, A-B-K bearings cut costs four ways:

Outwear metallic bearings—A-B-K laminated bearing material is extremely tough and slow-wearing. It is impervious to mild acids and alkalies, will not distort under shock and withstands temperatures up to 200° F. without failure. In actual service, A-B-K bearings customarily outwear metal several times.

Reduce power consumption—A-B-K Laminated Plastic Bearings have an exceptionally low coefficient of friction which produces remarkable savings in power. The A-B-K surface is self-renewing—actually polishes, but never scores, the shaft.

It will pay you to investigate fully the cost-cutting advantages of A-B-K Laminated Plastic Bearings for your mill. The complete engineering and research facilities of American Brakeblok are at your disposal... Write to arrange a consultation.

Eliminate lubricating oil—A-B-K bearings are successfully lubricated with *water*. Cost of oil or grease is eliminated entirely.

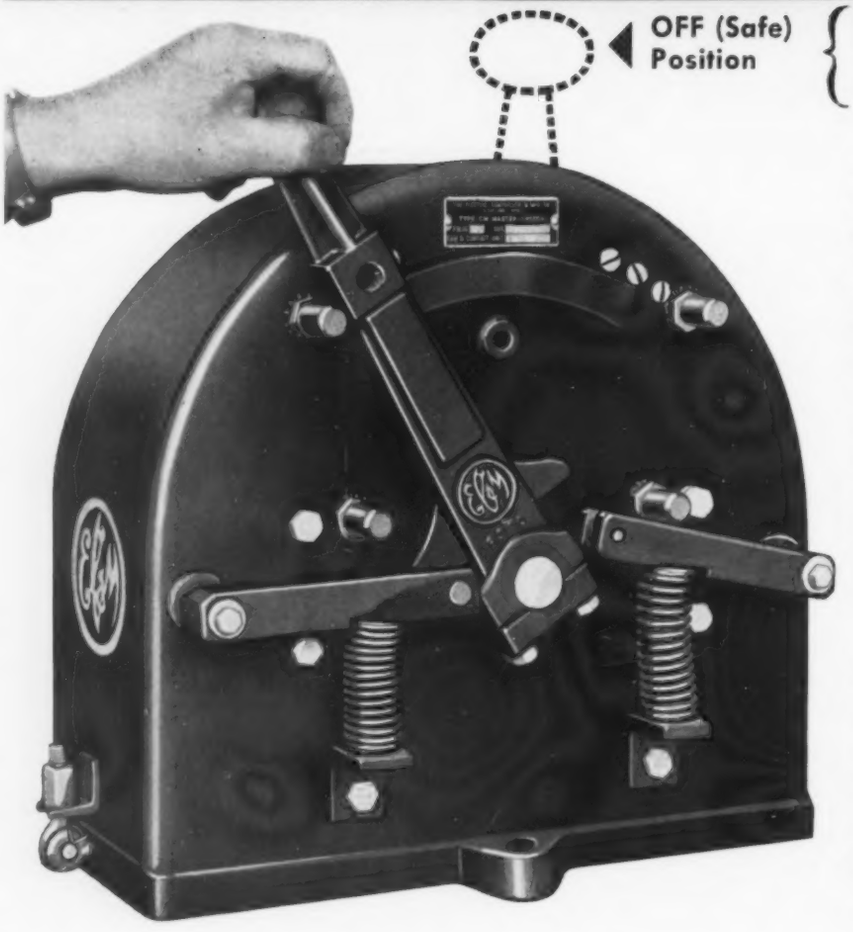
Require fewer adjustments—Because A-B-K bearings hold gauge longer, oversize requirements and need for roll adjustments are sharply reduced. This means fewer shutdowns—a higher percentage of productive time from each A-B-K equipped unit.

A-B-K
Laminated Plastic Bearings

AMERICAN Brake Shoe COMPANY

AMERICAN BRAKEBLOK DIVISION
DETROIT 9, MICHIGAN

Master Switch *automatically* returns to Off-Position from any speed-point in either direction . . .



Provides Safe Operation should operator fall or otherwise remove his hand from master-handle.

There are several *speed-control* applications where *safe* practice dictates that power be automatically disconnected from the motor-driven machine the instant the operator leaves his station or for some other reason removes his hand from the master switch. A typical example is a transfer (or larry) car with a *spring-return* master switch mounted on the side within reach of the operator as he walks along with the car. Should he trip and fall, the master switch automatically centers itself in the off (safe) position.

The EC&M Cam-type Master Switch (as illustrated) is ideal for this service because of the *short-throw* of the operating handle. From the "full-on" to the "off" position, the handle of an EC&M Master travels less than 40° from the sixth speed-point in either direction to the off (central) position. There's nothing to equal the EC&M Cam Master Switch for spring-return service.

Make your own Compact Layouts with EC&M Bulletin 1190 Cam MASTER SWITCHES

in Crane-cabs or Mill-pulpits

For new installations or when re-vamping existing equipment, take advantage of the narrow width and short-throw of EC&M Cam Master Switches for improved performance. These features appeal to operators.

Write for Bulletin 1190 giving details of these short-throw, narrow width Masters

THE ELECTRIC CONTROLLER & MFG. COMPANY

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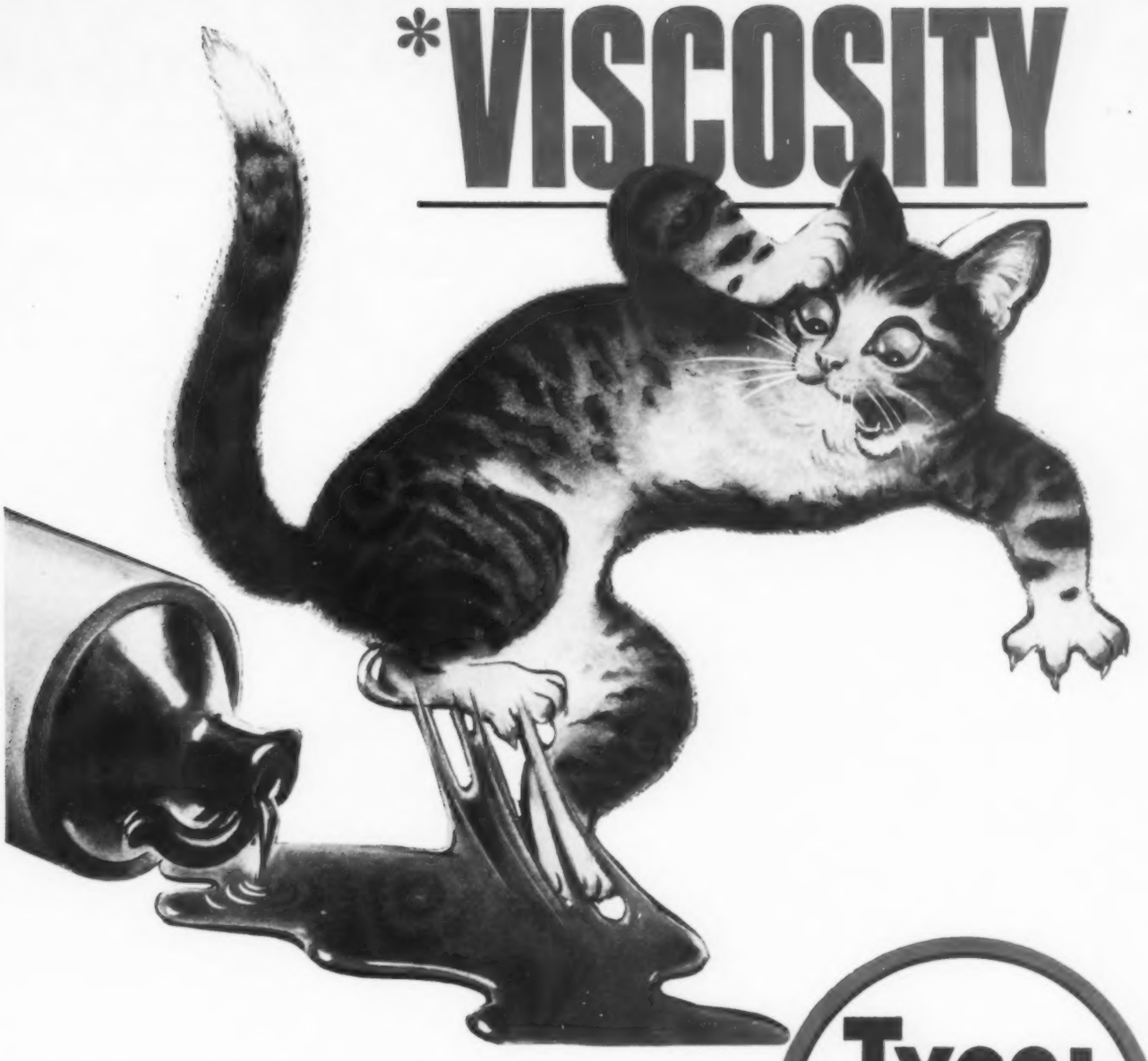
*VISCOSITY



All equipment will last longer — give better service — if you use the proper lubricant. That's why you'll find it profitable to use Tycol high quality oils and greases.

There's a reason! No matter what your lubrication need — for roll neck bearings or mine cars, Diesels or high speed textile spindles, turbines, paper calenders or steam engines . . . where *VISCOSITY, penetration, extreme pressure is a factor — Tycol has a lubricant suited to your specific requirements.

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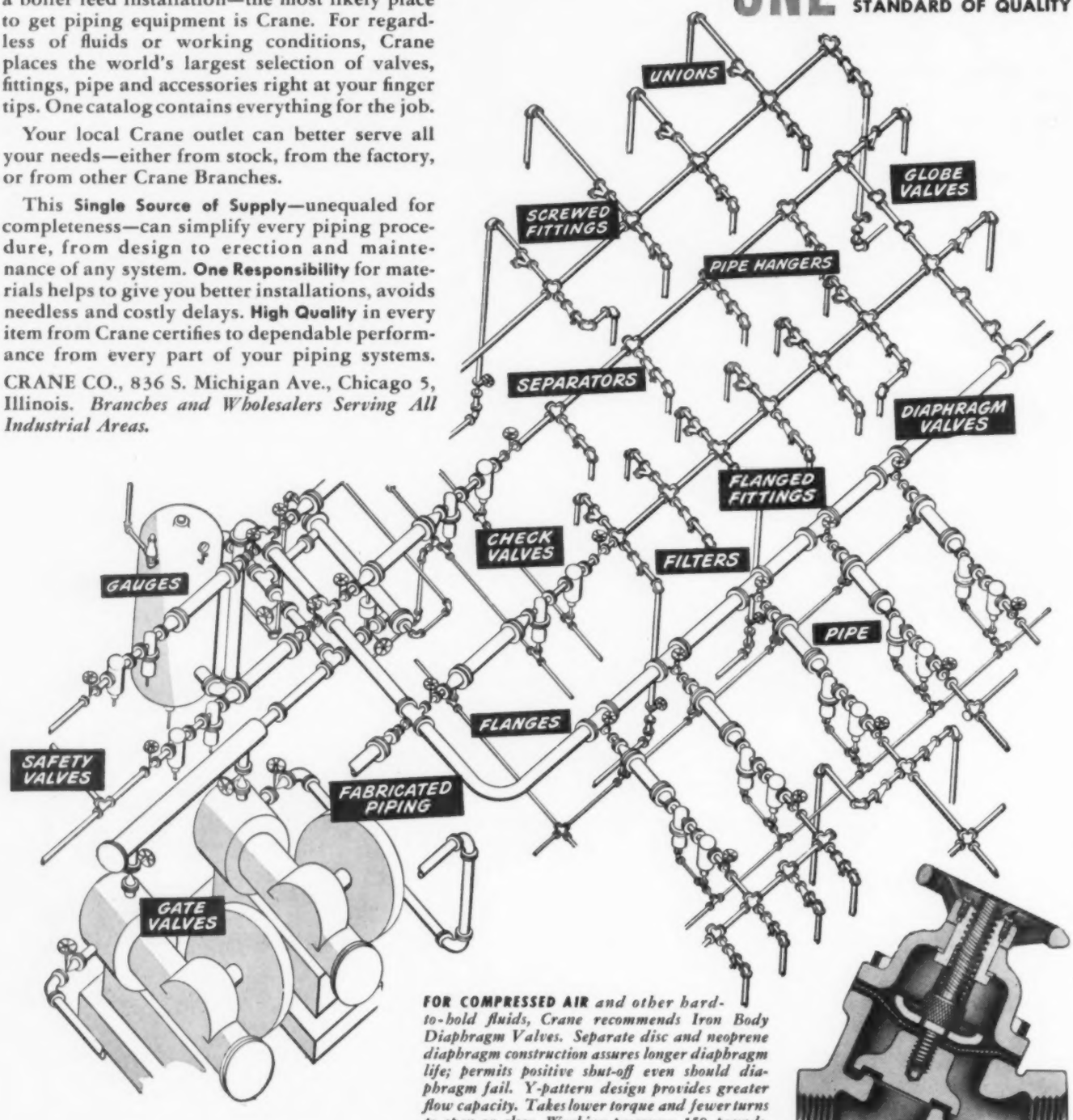

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Announcing...

A New Low-Cost Process for Production of WELDED PIPE ... in sizes from 8⅝" to 30" O. D.

Initial Investment Reduced by 60%

This completely new process embodies equipment for cold forming of skelp in specially designed hydraulic presses, and welding by the submerged arc method; also auxiliaries for conveying, processing, and finishing pipe in 40′ lengths, in the range of sizes indicated above. All the equipment, with minor exceptions, is engineered and built by Yoder.

A pioneer plant, in commercial operation for over a year, already has demonstrated high dependability, with exceedingly low production and maintenance cost.

From an operating standpoint it is thought that the most desirable tonnage requirements for the new type of mill will lie between 50,000 and 75,000 tons per year. With the addition of more welding units, the production may easily be raised to 125,000 tons.

Initial investment, maintenance and operating cost are so low that profitable operation under favorable circumstances may be maintained *on a production as low as 15,000 tons per year, or even less.*

Notable features of the new process are: Exceedingly low scrap loss and tooling cost; wide range of sizes which can be produced in the same mill, with one basic set of tooling; short set-up time for different sizes; small amount of operating skill required. (Low scrap loss is especially important with operators not producing their own steel plate.)

Biggest single consideration, however, for production within the limits mentioned, in most cases will be low initial investment in plant equipment — only a small fraction of that necessary with any of the older processes of pipe making.

Where greater production is required, Yoder electric-weld Tube Mills, now as in the past, remain the most efficient and economical for sizes from ⅜" up to 12" O.D., or larger.

Detailed information may be had for the asking. Your inquiries will receive prompt and careful attention.

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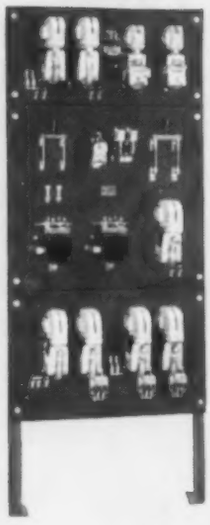
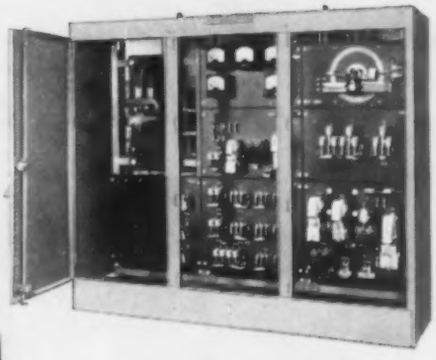
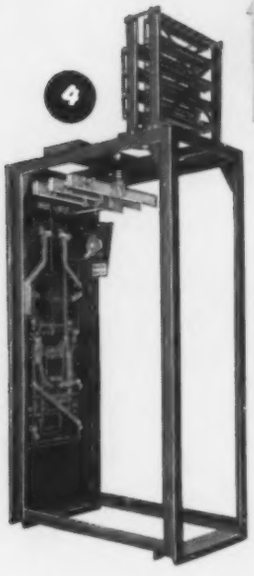
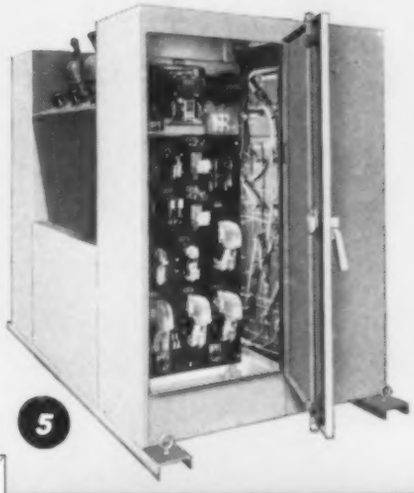
STANDARD AND SPECIAL
HEAVY-DUTY D.C. MILL AUXILIARY & CRANE CONTROL









1 **Dynamic Lowering Control Panel** for cab-operated crane hoist. New network system gives surer hook control with only nine contactors. ***STANDARD***

2 **Steel Mill Auxiliary Controller** for reversing, dynamic braking service. Features include automatic acceleration by pneumatic timers, mill type overload relays, heavy duty control relays and contactors. ***STANDARD***

3 **Variable Voltage Controller** for continuous strip process line. With motor-operated field rheostat. ***SPECIAL***

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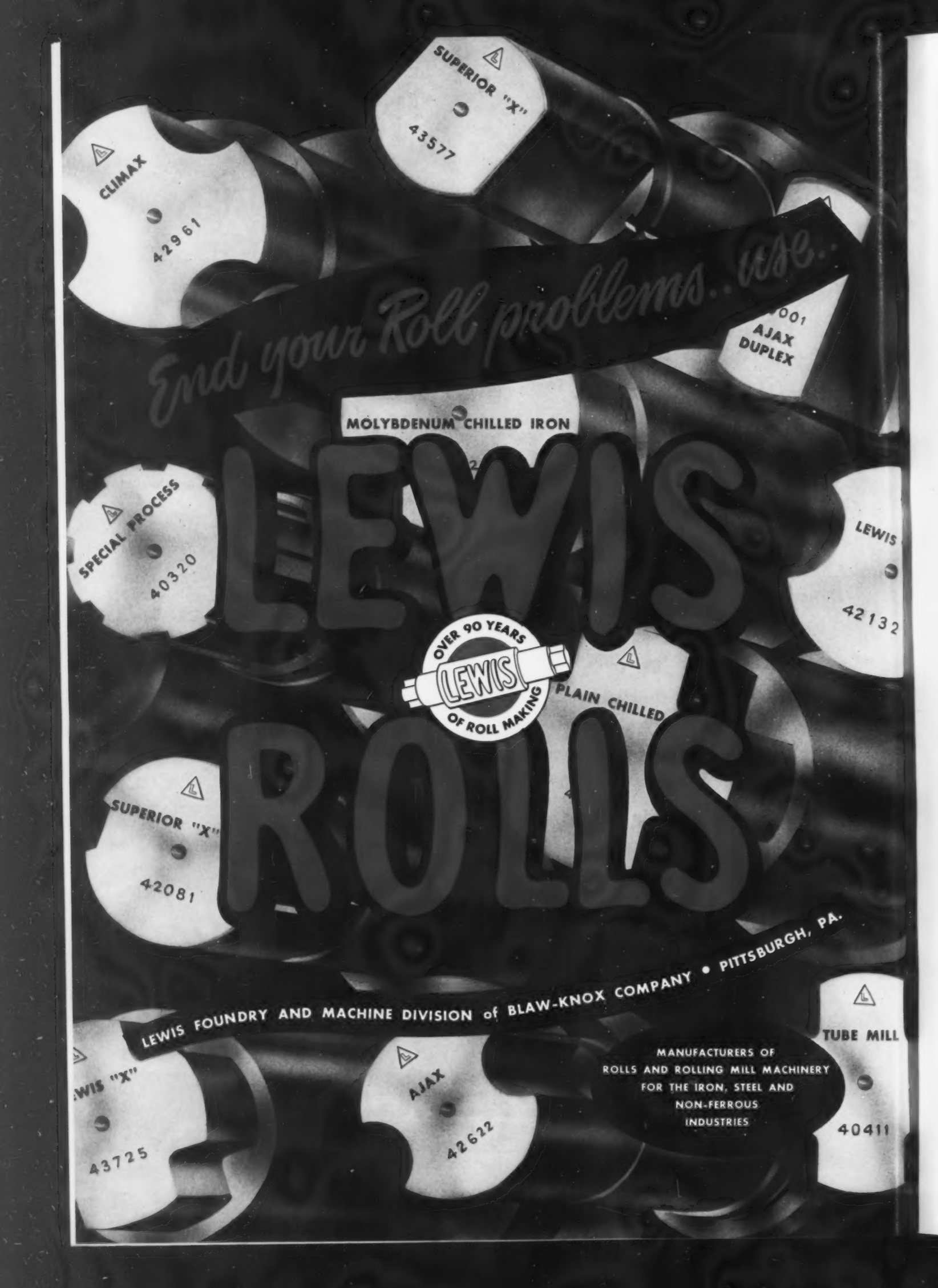
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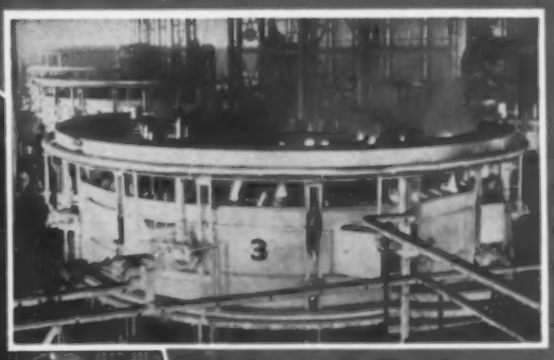
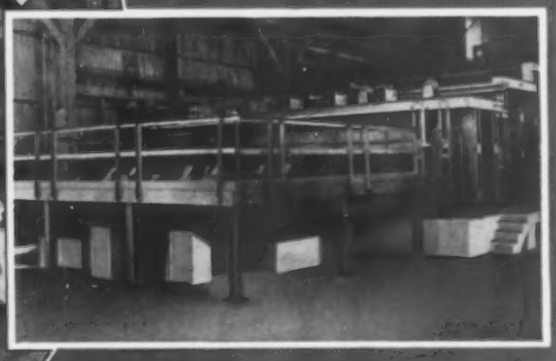
IT'S LOFTUS *all* *Along the Line*





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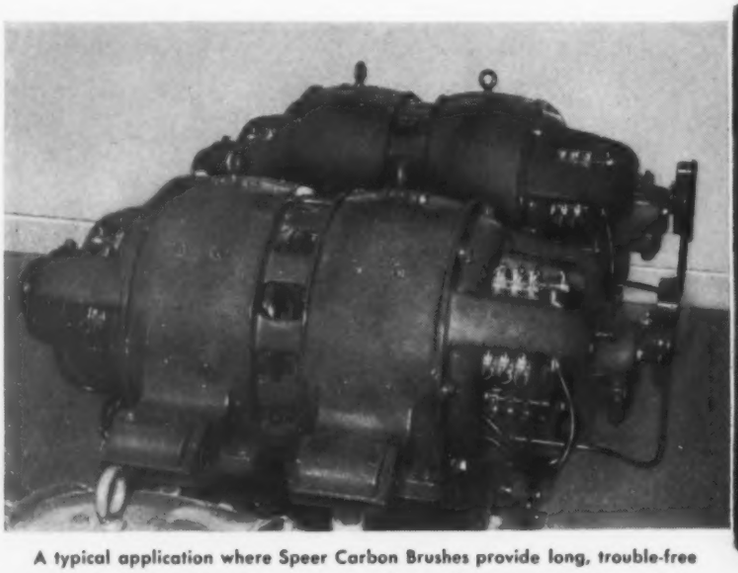
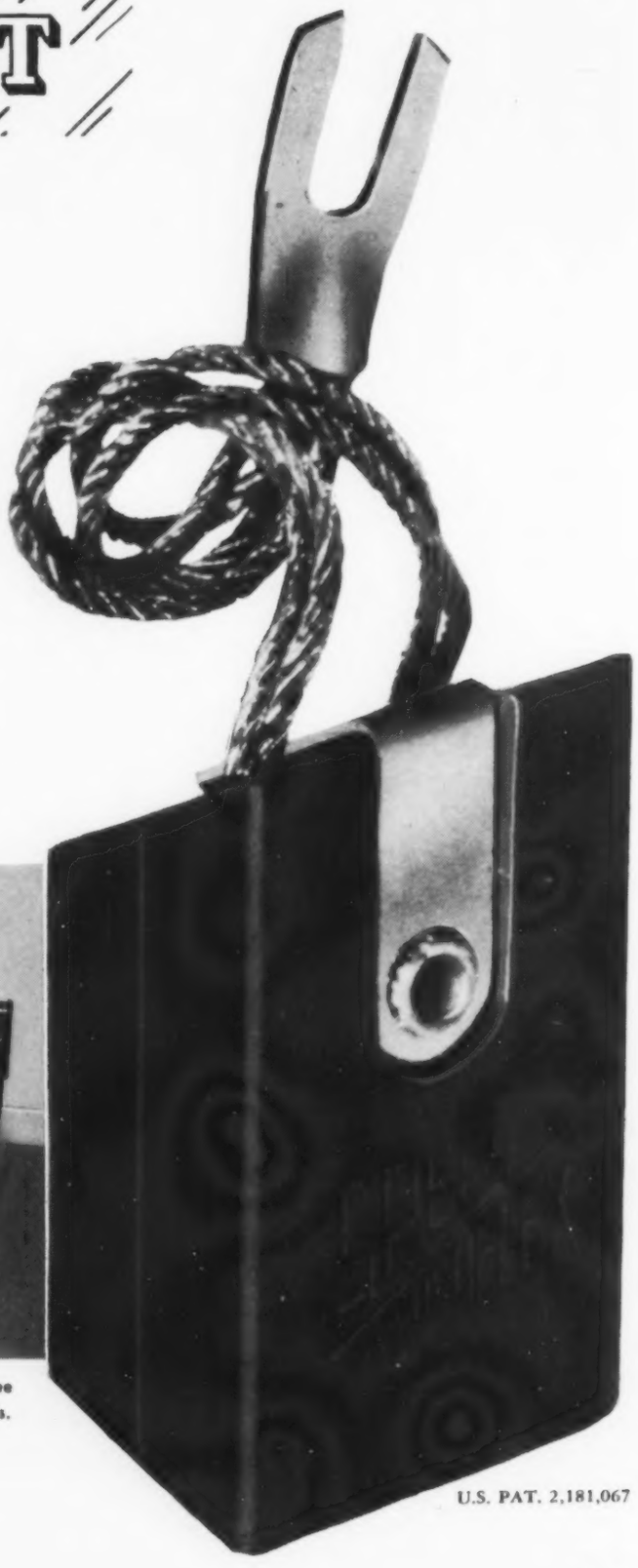
REFLECT Quality

Reflected in the fine reputation Speer Carbon Brushes have enjoyed for more than half a century is their uniformly superior quality. Careful selection of raw materials, and processing according to standards established by Speer under actual severe service conditions throughout its long years of experience, account for this high quality—laboratory testing assures it before any Speer Carbon Brush is sold. That's why you can be sure of long, trouble-free commutation when you specify "Speer" for all your electric motor and generator requirements.



A typical application where Speer Carbon Brushes provide long, trouble-free service is in motor-generator sets such as these, which power elevator controls.



U.S. PAT. 2,181,067

5020

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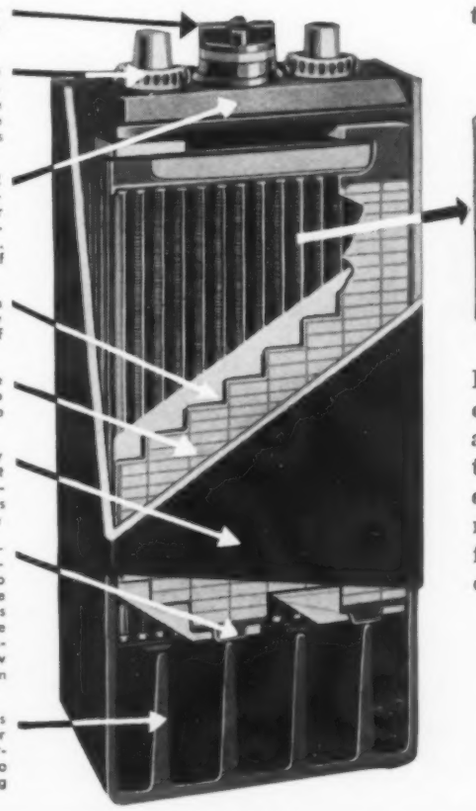
EXIDE-IRONCLAD BATTERIES ARE DIFFERENT!

They are specially designed to provide years of dependable service in all MOTIVE POWER WORK

Storage batteries are called upon to perform many tasks. No single type of battery is adequately suited to all. To meet these numerous requirements, Exide engineers have developed special types, to fit each application.* Among these several types is the specially designed Exide-Ironclad Battery. Details shown below.



VENT PLUG specially designed to prevent escape of electrolyte.

GREASE SEAL RING NUT holds battery elements securely in place . . . prevents creepage of electrolyte . . . keeps tops clean and dry.

SEALED CELL COVER flush with top of jar. Prevents collection of dirt or moisture . . . keeps impurities out of cell . . . eliminates leakage of electrolyte.

SEPARATOR of high porosity, specially treated to last the life of the battery.

NEGATIVE PLATE made extra heavy and built to match the long life of the positive plate.

JAR made of specially tough and durable Giant Compound. Built to withstand the jolts and jars of hard industrial usage

FEET. Internal short circuits practically eliminated because the two feet on negative plate rest on different ribs from those of the positive plate, and because separators extend below both plates and rest on all four ribs.

RIBS support all plates and separators. Their height provides generous sediment space so that internal cleaning is unnecessary.

DIFFERENT IN DESIGN
DIFFERENT IN CONSTRUCTION
DIFFERENT IN SERVICE QUALITIES

Chief among these differences is the unique positive plate, an exclusive Exide feature.

EXIDE-IRONCLAD POSITIVE PLATE

Consists of a series of finely-slotted tubes which contain the active material. So small are these slots that, while permitting easy access of electrolyte, they retard the active material from readily washing out or jarring loose . . . adding considerably to life of plate.

Exide-Ironclad Batteries have ALL FOUR of the characteristics that a storage battery must have to assure maximum performance from battery electric industrial trucks — high power ability, high electrical efficiency, ruggedness and a long life with minimum maintenance. The combination of these four Exide-Ironclad characteristics assures years of dependable day-in, day-out service.

"Exide" and "Exide-Ironclad"
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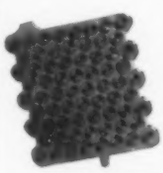
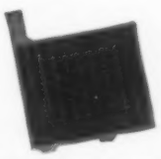


DESIGNED FOR STATIONARY USE

The Exide-Manchex Battery has the manchester type positive plate with the lead button construction. Specially designed for stationary use in many classes of industry.

DESIGNED FOR AUTOMOBILE USE

The Exide Automobile Battery has plates of staggered grid construction. Specially designed for use in automobiles, trucks, buses, aircraft and numerous other applications.



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THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32 • *Exide Batteries of Canada, Limited, Toronto*

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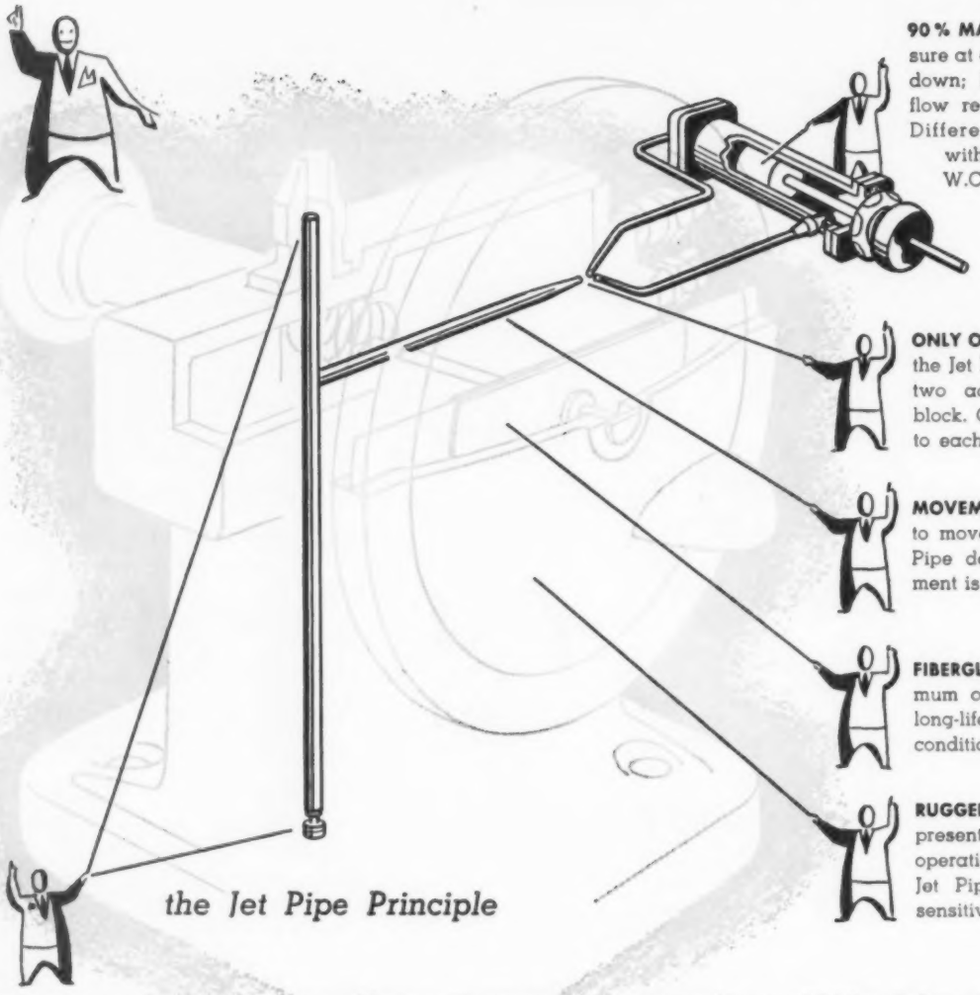
Askania Controls



the Jet Pipe Principle

90% MAXIMUM RECOVERY of inlet pressure at operating cylinder; 10 to 1 turndown; 1% accuracy over range; (i.e., flow regulator designed for 3" W.C. Differential Pressure would control within an accuracy of ±.03" W.C.).

ONLY ONE MOVING PART in the relay—the Jet Pipe—which discharges oil into two adjacent orifices in distributor block. One of the orifices is connected to each side of piston.

MOVEMENT OF JET PIPE causes piston to move at a rate proportional to Jet Pipe deflection. Total Jet Pipe movement is less than one degree.

FIBERGLAS DIAPHRAGM presents maximum of sensitivity with maximum of long-life, detects changes of operating conditions as small as .0025" W.C.

RUGGED CONSTRUCTION of regulator presents best possible protection for operation of single moving part—the Jet Pipe, combining sturdiness with sensitivity and accuracy.

JET PIPE needs support at only two points, upper and lower bearings, by fitted connections always bathed in oil to provide constant lubrication and prevent friction (oil flow enters Jet Pipe at top inlet bearing).

THESE SIX POINTS add up to why you'll like Askania Controls. Accuracy, sensitivity, stability, simplicity, ruggedness, maintenance-free operation: all points you can be sure of when you specify Askania Control. The reason for this is the Jet Pipe, heart of all Askania Regulators, a simple, accurate relay with only one moving part. By the Jet Pipe Principle, minute pressures or signals from the source of measurement are amplified into a powerful force.

For tough control jobs . . . for applications where dependability is all important . . . for processes requiring extreme accuracy, Askania Jet Pipe Controls are the ideal answer.

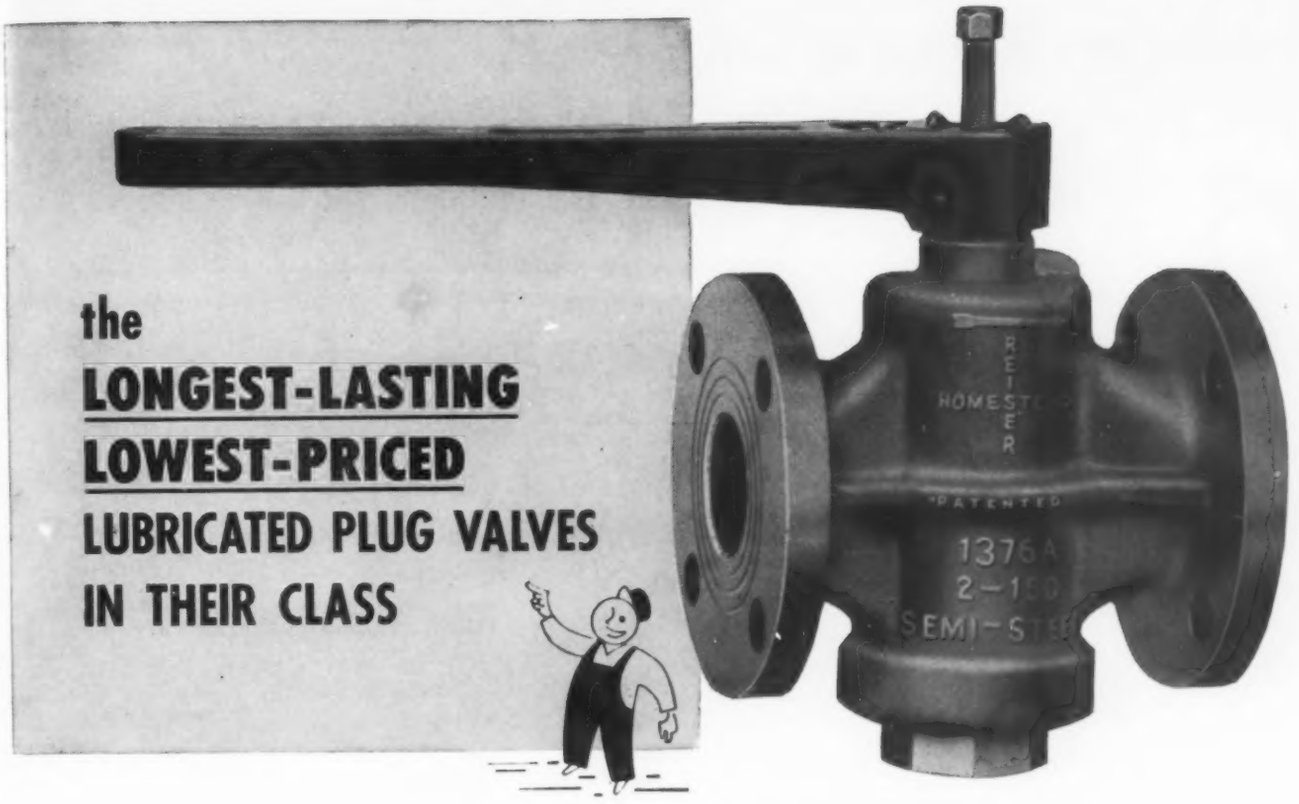
Ask for Bulletin 139J

ASKANIA Controls

ASKANIA REGULATOR COMPANY

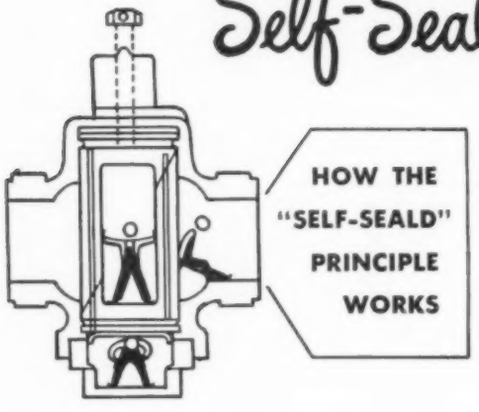
A Subsidiary of General Precision Equipment Corporation

240 East Ontario Street, Chicago 11, Illinois



HOMESTEAD-REISER

Self-Sealed LUBRICATED PLUG VALVES



In addition to a full lubricant seal around the ports and around the top and bottom of the valve, the wedge-action of the plug under line pressure, constantly presses the finely-finished surfaces of the plug outward against the seating surfaces of the body. This self-sealing action keeps the plug surfaces in contact at all times with the mirror-like bore of the body. The plug thus automatically adjusts itself for wear, assuring extra long life and maximum leakless service.

In both screwed and flanged types, Homestead-Reiser Valves are the lowest-priced, full-port-area valves in the 200 lb. oil-water-gas, 150 lb. steam working pressure class.

They provide:

- **100% area of standard pipe**
- **100% lubricant seal around ports**
- **Patented "Self-Seald" Principle with *automatic adjustment for wear***
- **Single lubricant for wide variety of applications**
- **Extreme economy of lubricant**

We designed and built Homestead-Reiser Valves to outlast all other lubricated plug valves in their class. Their ability to do so, and their superior performance in service, have been established in practically every industry during the past seven years.

For full details write for Catalog 39—Section 5

HOMESTEAD VALVE MANUFACTURING CO.

"Serving Since 1892"

P. O. BOX 21 **CORAOPOLIS, PA.**

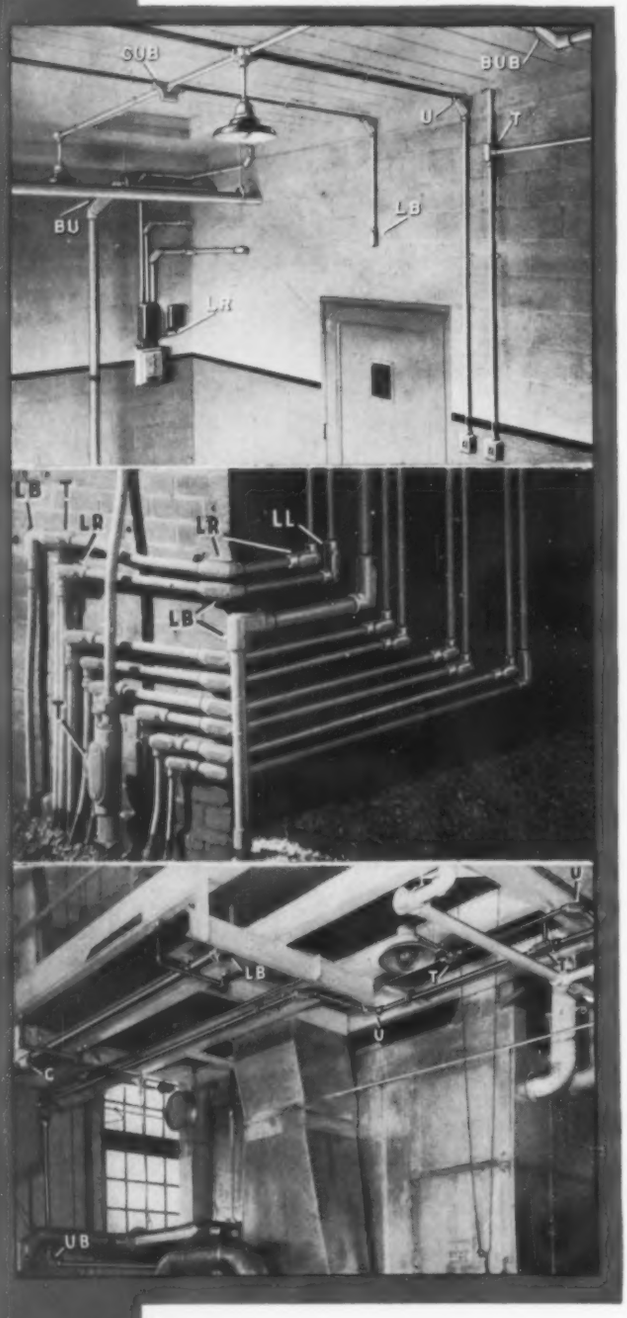
Installing electrical conduit?

SPECIFY

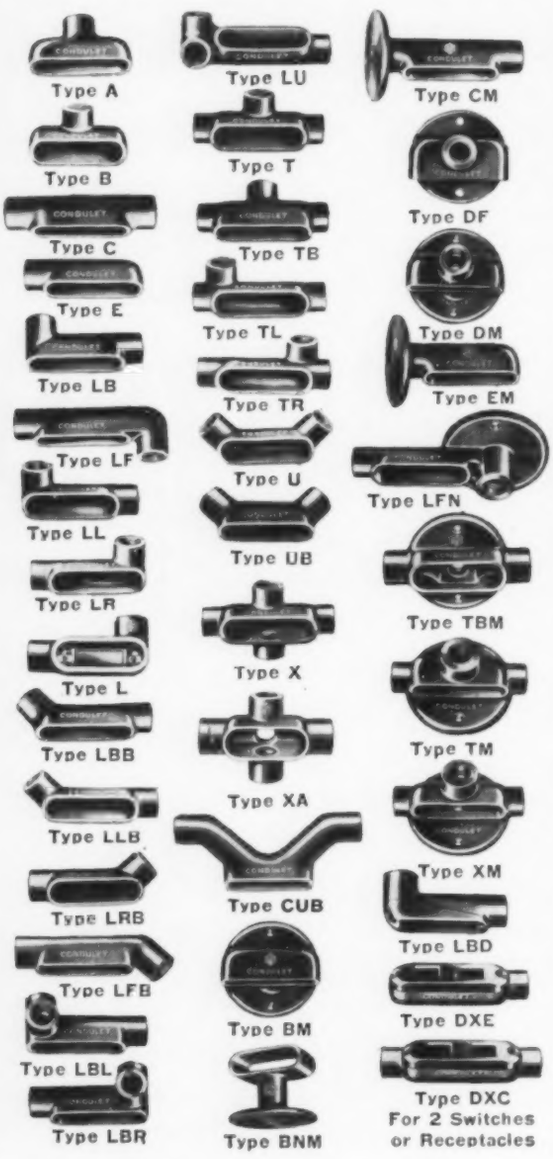
Obround CONDULETS*

because they are so handy and there are

49 different types



A wide variety of interchangeable covers and wiring devices with Crouse-Hinds' exclusive Wedgenut Fastener; sizes to fit ½ to 6-inch electrical conduit.



A Nationwide Distribution Through Electrical Wholesalers

* *CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.*

The complete Obround Series, together with 15,000 other items for the electrician, is listed in Crouse-Hinds Condulet Catalog.

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CROUSE-HINDS COMPANY OF CANADA, LTD., *Main Office and Plant:* TORONTO, ONT.

CONDULETS · TRAFFIC SIGNALS · AIRPORT LIGHTING · FLOODLIGHTS

wherever motor
hazards lurk...
Specify WAGNER
PROTECTED MOTORS
Do you use motors in locations where dirt, filings, moisture, splashing liquids, acid fumes, explosive gases, or other motor hazards lurk? No matter how severe the operating condition, Wagner has the right motor for your purpose—adequately protected against such hazards. Five types of Wagner protected motors are shown below.

1. Wagner Totally-Enclosed Motors . . .
PROTECTED against dust, dirt, abrasives, steel chips, filings, acid fumes, and other harmful elements that may damage the windings and bearings.

2. Wagner Explosion-Proof Motors . . .
PROTECTED to prevent explosion in locations where gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors, or natural gas are manufactured, used, or handled. Approved by Underwriters' Laboratories for Class I Group D hazardous locations.

3. Wagner Drip-Proof Motors
PROTECTED to keep dripping liquids, falling metal chips and other particles from entering the motor.

4. Wagner Splash-Proof Motors . . .
PROTECTED against splashing or dripping water, oil, or other liquids. They are widely used in exposed outdoor locations, and are completely self-protected against ice, sleet, snow and rain.

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PROTECTED to resist the action of acids, fumes, moisture and other harmful elements encountered in chemical manufacturing.

Bulletin MU-185 gives full information on the complete line of Wagner Motors. Write for your copy today.

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Consult Wagner Engineers on all Electric Motor Problems

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ELECTRICAL EQUIPMENT AND AUTOMOTIVE BRAKE PRODUCTS

M49-18

EXPLOSION-PROOF PYLETS ... for Hazardous Locations

EXPLOSION-PROOF SWITCH PYLETS

1. *TUMBLER SWITCHES with push-pull Rod* to control motors or lighting circuits in hazardous locations. 1 and 2 gang, 1, 2 and 3-pole, 10 to 30 ampere, also 3 way and 4 way, 10 and 20 ampere types.

2. *TUMBLER SWITCHES with interlocking Plug* Receptacle for use as service outlets for portable electrical equipment in hazardous locations. Plugs cannot be inserted or withdrawn unless switch is open. Switch cannot be closed unless plug is fully inserted. 2 and 3-pole, 20 and 30 ampere, 250 and 460 volt ratings.

3. EXPLOSION-PROOF SECONDARY CIRCUIT BREAKER PYLETS for protection of motors against overloads and stalled rotor currents. Can also be used for "on" and "off" switch. Single and double pole with a selection of interchangeable heater units for protecting fractional horsepower motors.

4. EXPLOSION-PROOF UNIVERSAL JUNCTION PYLETS—6, 7 and 10 hub types with close-up plugs. For easy replacement of sheet metal knockout boxes in the rewiring of old gasoline pump installations.

5. EXPLOSION-PROOF JUNCTION PYLETS available in a wide selection of styles and sizes with threaded or union type hub. Furnished with plain covers for general use or with covers tapped for conduit to support lighting fixtures. Also furnished with pipe plug angle type cover for filling with sealing cement.

6. PYLE-O-FLEX flexible explosion-proof and watertight fittings for adjustable and vibrative connections to motors, floodlights and pendant type lighting fixtures. Furnished in any combination of male and female threaded or female union type end connections with flexible lengths of 4 to 36 inches, conduit sizes ½" to 2" inclusive.

7. EXPLOSION-PROOF SEALING PYLETS have removable pipe plug covers which can be mounted in any one of four positions for filling with cement. Used to isolate the wiring compartments of arc-producing devices from balance of conduit system.

EXPLOSION-PROOF UNIONS, male and female, straight and 90° elbow types.

A line of the most commonly used types of conduit fittings for hazardous locations as defined in Article 500 of The National Electrical Code. Explosion-proof Pylets are designed in accordance with Underwriters' Laboratories requirements and are classified in their list of inspected electrical appliances. Their substantial construction and the high quality of materials and workmanship insure safety, uninterrupted service and long life Consult your Pylet Catalog 1100 for complete listings of the above and other Explosion-Proof and Dust-Tight Pylets.

THE PYLE-NATIONAL COMPANY

1370 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS
DISTRICT OFFICES and REPRESENTATIVES in Principal Cities of the United States
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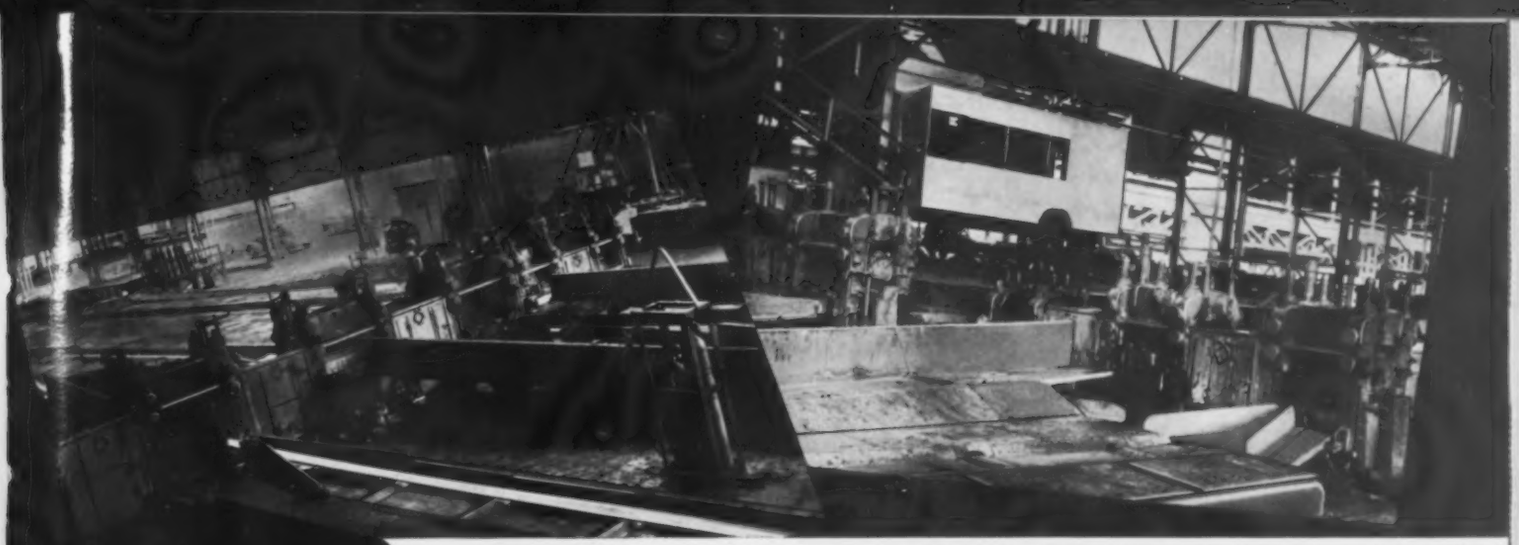

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FOUNDRY & MACHINE CO.

CHICAGO · PITTSBURGH

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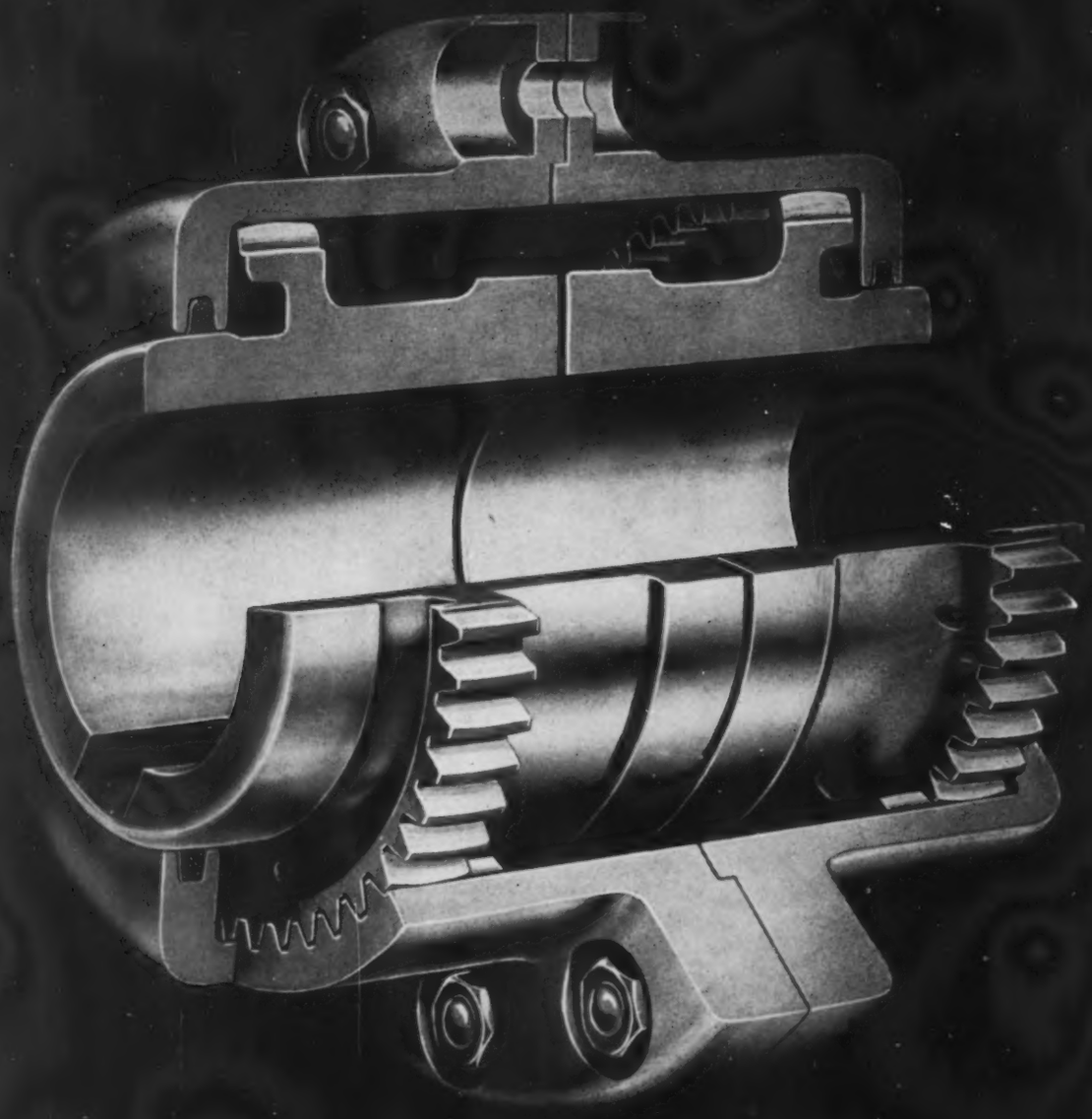
POOLE



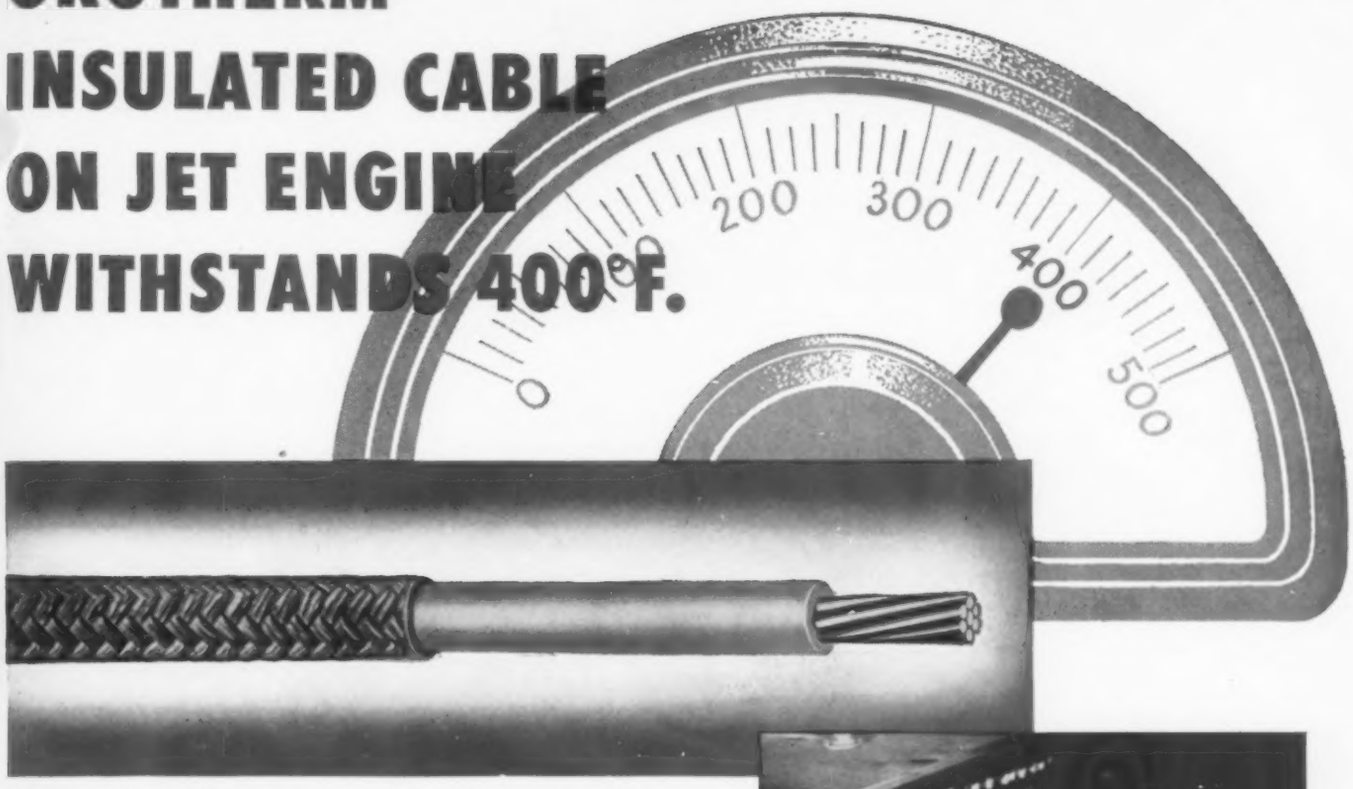
COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

OLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

OKOTHERM INSULATED CABLE ON JET ENGINE WITHSTANDS 400° F.



Okotherm cables for high temperature service can be made in a wide range of sizes and types, using glass, asbestos or other protective coverings.

THE REMARKABLE heat-resisting quality of Okotherm insulated cables has been highlighted by their adoption in a jet engine that develops temperatures as high as 400° F. As a result of intensive investigations by Okonite researchers of heat-resisting materials, it was found that ignition wire insulated with Okotherm would fulfill the requirements. Consequently it became the first to gain approval for the new engine.

Compounded with silicone, Okotherm insulation retains its dielectric strength after long-time exposure to high temperatures as well as those as low as —65° F. Okotherm insulation helps wiring withstand outdoor weathering without deterioration—keeping flexible at all operating temperatures, resisting oxidation and ozone.

In addition to high voltage ignition, cables with Okotherm insulation should be considered for electric ovens, furnaces and motors, high-intensity floodlights, street lights and neon signs—wherever excessive heat must be encountered.

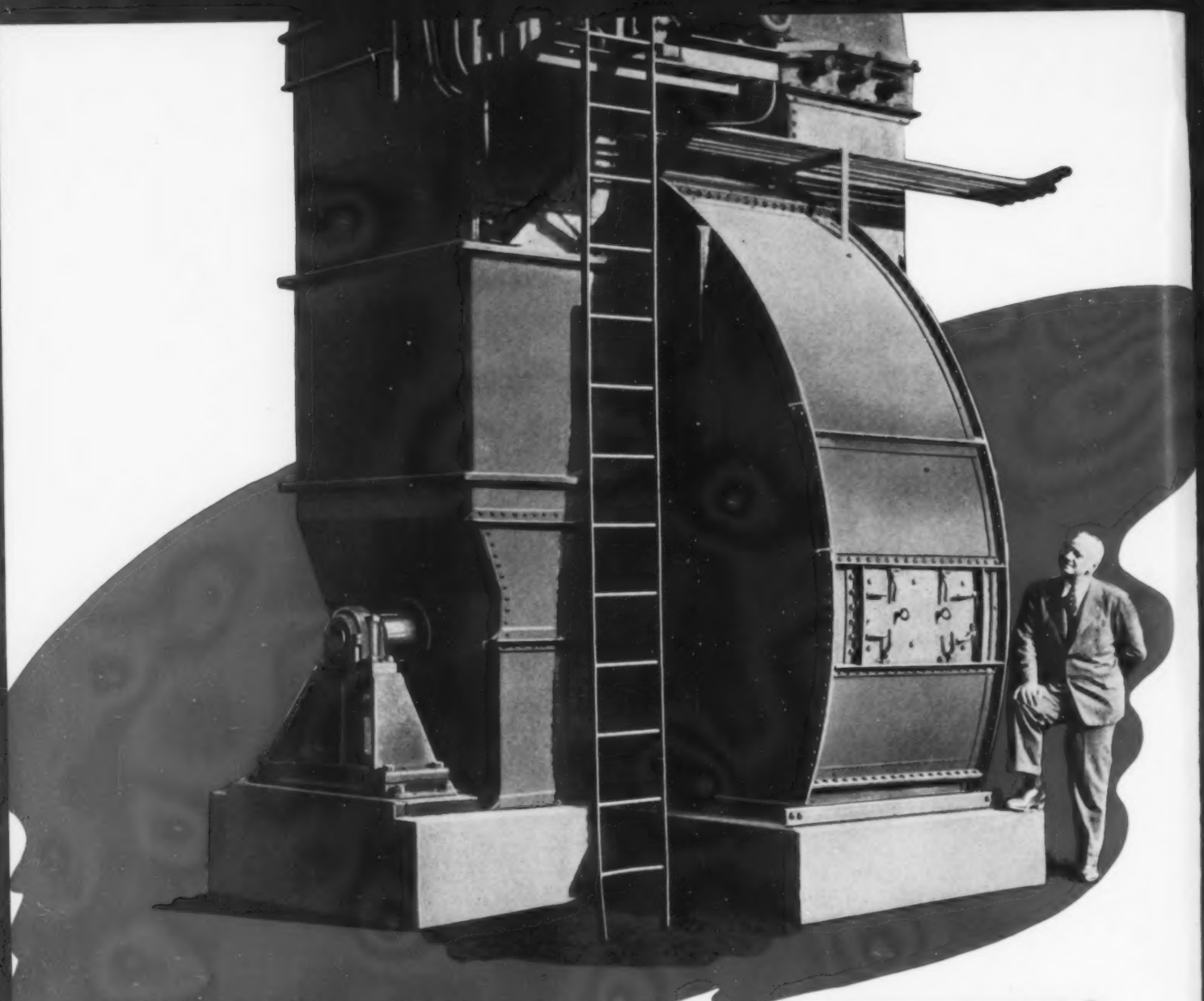
Oven and freezing tests show that Okotherm insulation retains its properties over a wide temperature range where ordinary insulations fail due to loss of elastic properties or thermal instability.

If you should have no immediate use for heat-resisting Okotherm, some other special-purpose Okonite cable may fit your needs. "Unusual" cable installations have a way of turning out to be Okonite. Problem solving is our business. Why not talk over your cable problem with an Okonite engineer? The Okonite Company, Passaic, New Jersey.

THE BEST CABLE IS YOUR BEST POLICY

7119

OKONITE — SINCE 1878 — *insulated wires and cables*



BUILT TO "TAKE IT" IN THE PUNISHING *Sintering* JOB

"BUFFALO" SINTERING FANS

Here's one of the severest fan services! A sintering fan has to keep operating under heat conditions from 300–500° F., against pressures from 10 to 20 inches of water. Moreover the hot gases it handles are charged with heavy, abrasive dust or cinder which could eat an ordinary fan to powder in a short time.

But the "Buffalo" Sintering Fan is equal to this service. Extremely rugged, as you can see by the photo, its blades and housing are extra heavy plate, shafts and bearings are extra sturdy.

This sintering fan is one of many special "Buffalo" designs. For corrosive fume removal, pressure blowing, mill motor cooling — there's a "Buffalo" Fan built with this same "Air Know-How" that means longest life and lowest cost on the job. Call in your nearest "Buffalo" engineering representative for the facts — it will pay you over and over!

If Your Job Has To Do With AIR — You Need This Factual Book!

FAN ENGINEERING, 5th Edition, gives you the quick practical answers on nearly every air problem encountered in today's complex applications. 808 pages, handy pocket size, conveniently indexed. The book the experts consult — a "wealth" of information — yours for only $6.00 Postpaid in U. S. A.

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VENTILATING FORCED DRAFT | AIR WASHING COOLING | AIR TEMPERING HEATING | INDUCED DRAFT | EXHAUSTING

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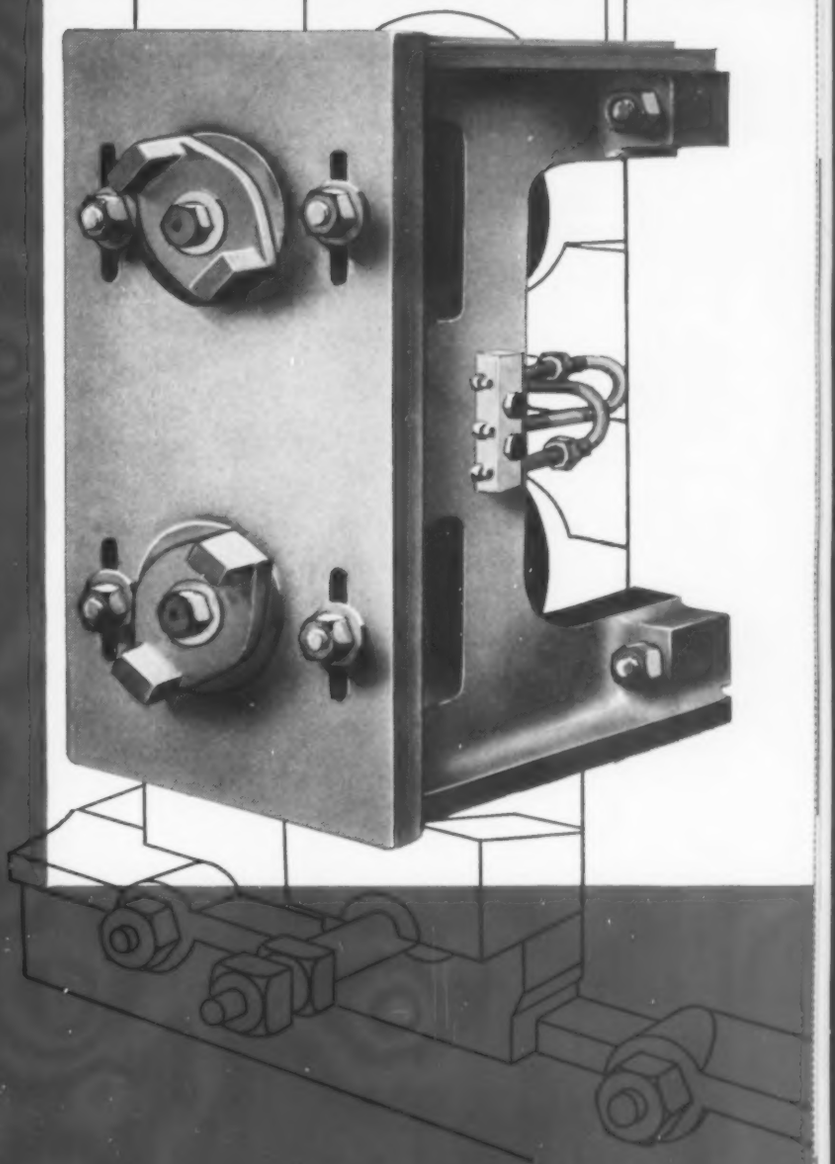
end-thrust bearing

Improves Operating Efficiency of Rod, Bar and Shape Mills



Not much for glamour, but a bear for work, this Mack-Hemp End-Thrust Bearing does an all-'round job of improving the operation of rod, bar and shape mills.

Developed by Mackintosh-Hemphill engineers to establish precise control over the axial matching of roll passes, this thrust bearing is a self-contained, compact unit which will team up with any type of good radial neck bearing, and which can be used on any mill stand where one end of the rolls is available for its attachment.

One of the most important features of the Mack-Hemp Bearing is the simple end-wise adjustment device which assures matched grooves and precise product tolerance on high-speed finishing stands.

Other advantages observed in exhaustive tests include:

- **Elimination of conventional side thrust collars**
- **Permanence of roll groove alignment**
- **Increased life of roll grooves and guides**
- **Long life of anti-friction thrust bearings**
- **Reduced electrical loads in starting and running mill**

Latest in the long list of products designed to improve metal-rolling techniques, this Mack-Hemp End-Thrust Bearing has passed every operating test. Full details are available—a qualified engineer is ready to show you why you should keep an eye on what's new at Mack-Hemp.

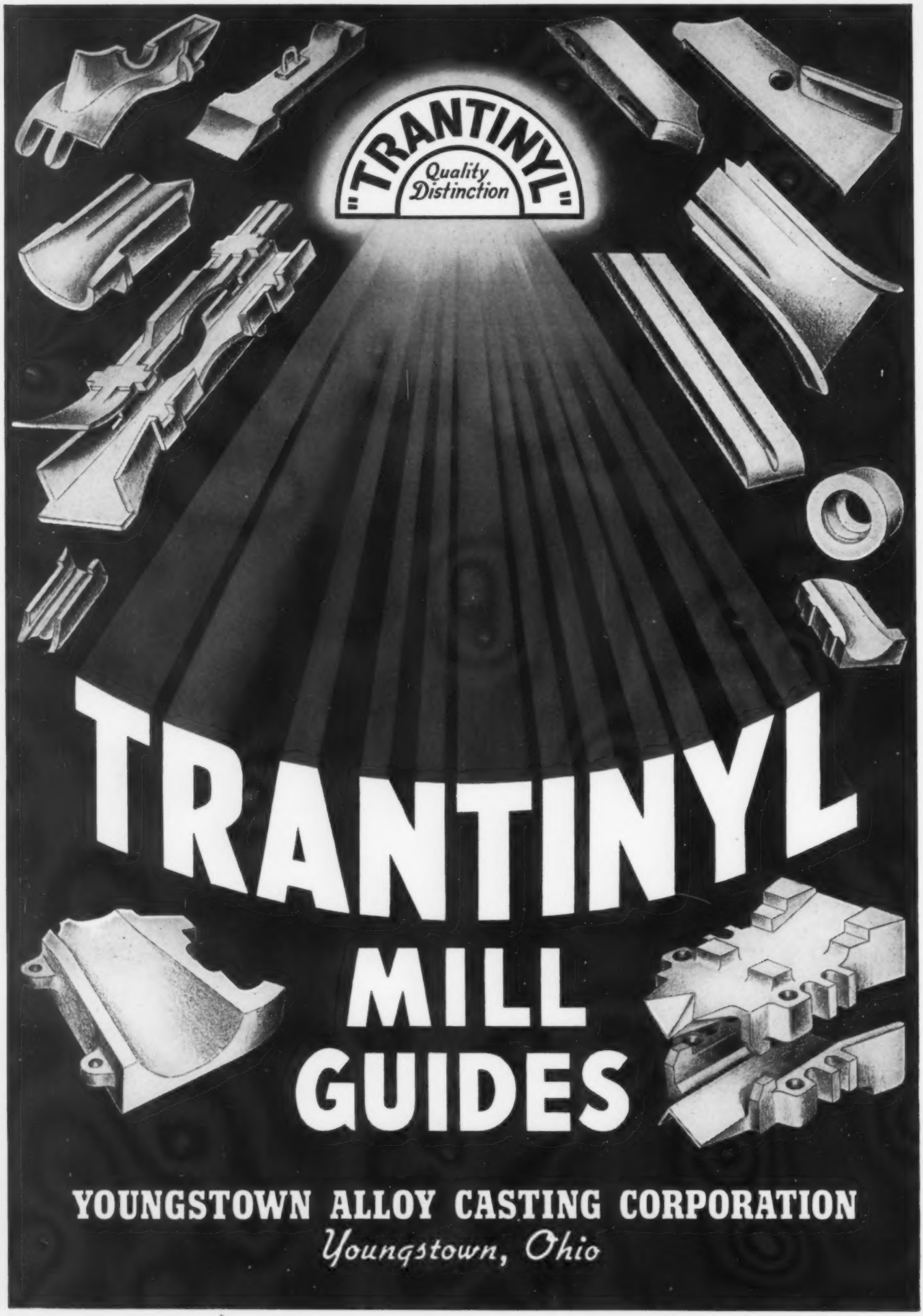
MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PA.

Makers of the Rolls with the Striped Red Wabblers

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE:

rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . the new Mackintosh-Abramson straighteners . . . improved Johnston patented corrugated cinder pots and slag handling equipment . . . shape straighteners . . . shears . . . levellers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YOUNGSTOWN ALLOY CASTING CORPORATION
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Increase Efficiency Throughout the Mill

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Morgan Equipment

1. Available to you is a staff of **Rolling Mill Specialists** always ready to show you the newest ideas in mill layout and equipment.
2. **Morgoil Roll Neck Bearings** on your present stands will increase the accuracy of your products and increase the yield and reduce maintenance costs.
3. **Morgan-Connor Wire Machines** are designed to operate faster and more efficiently, to reduce power, die and maintenance costs and to make the maximum use of floor space.
4. Increase furnace capacity and efficiency with an **Isley Furnace Control System.** It gives positive control of the furnace, makes better use of fuel, melts more metal per hour.
5. Control hot gases and fumes with a **Morgan Air Ejector.** Gases as high as 3000° F. can be handled without injury to the equipment because they do not pass through the fan.

Our entire organization is ready to go to work on your problem. Why not get in touch with us?

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YOU CAN BE **SURE**.. IF IT'S

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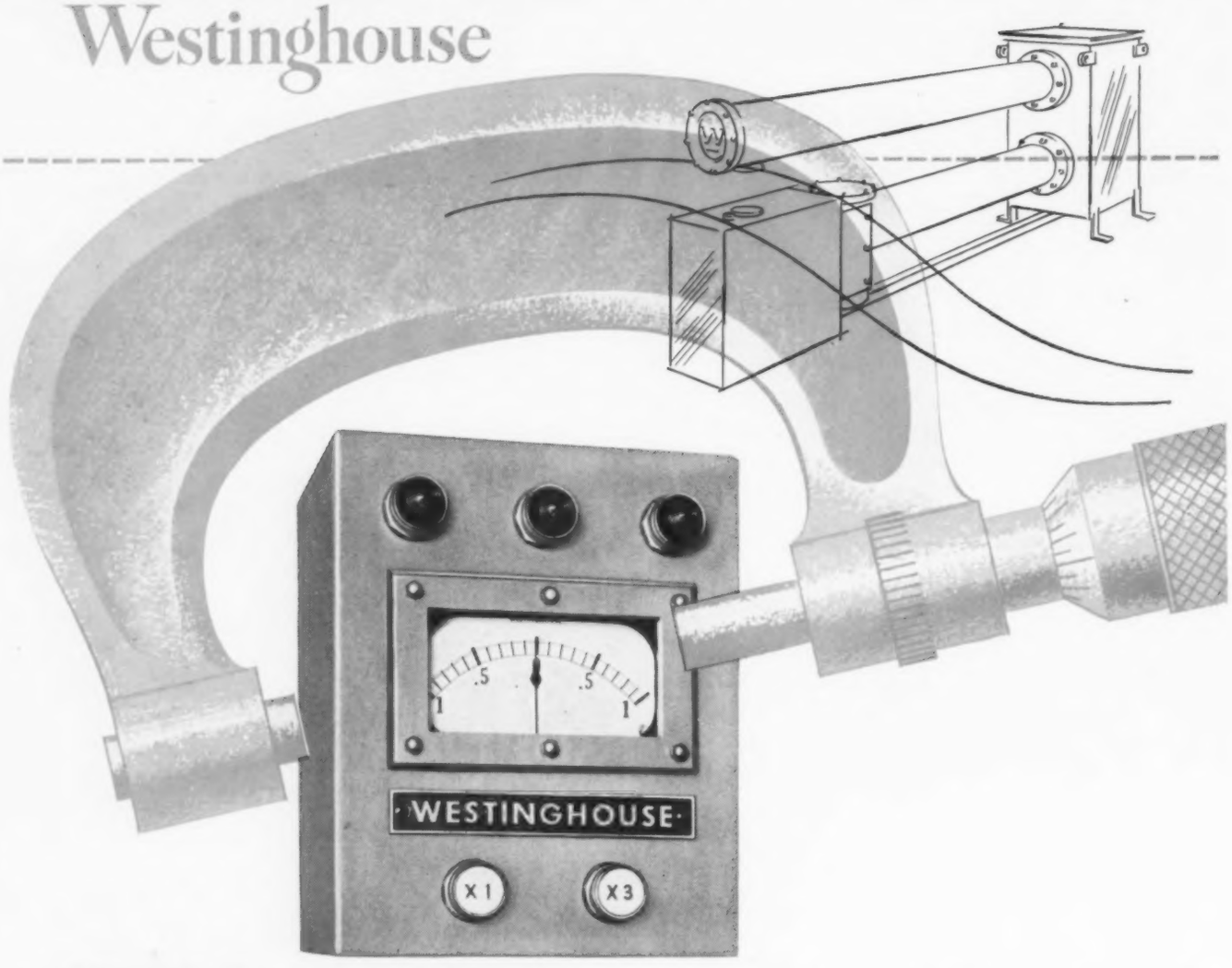

STOP COSTLY "overs" and "unders"

. . . with this X-RAY Thickness Gauge

Facts speak for themselves where quality and economy are dependent upon *rigorously* keeping to thickness standards. Compare the Westinghouse X-Ray Thickness Gauge with your present method of gauging the steel strip on high-speed, cold reduction mills or slower classification lines. It's FASTER . . . employs the direct comparison method of gauging which is independent of strip speed, yet holds to minute tolerances. It's FOOLPROOF . . . no mechanical gauging wheels to maintain . . . no contact between gauge and sheet . . . no damage to strip surface. It's POSITIVE . . . no manual handling of calibration samples . . . operation and calibration of the gauge are handled by remote control from the operator's control panel. And above all, it's ACCURATE . . . tolerances are maintained to within ± 2% . . . variations show up immediately on the indicating meter shown above, or may put reject gates into operation.

Consider these time and moneysaving "extras", too:

- Rugged mechanical construction and complete circuit stability which prevent costly shutdowns.
- No loss of time for setups . . . each new run can be set up rapidly and easily.
- Easy installation for lateral strip scanning.

You've been asking for a thickness gauge like this . . . and now it's here! Controlled accuracy that insures quality and assures economy. Your local Westinghouse representative can give you all the facts today. Call him or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-08227

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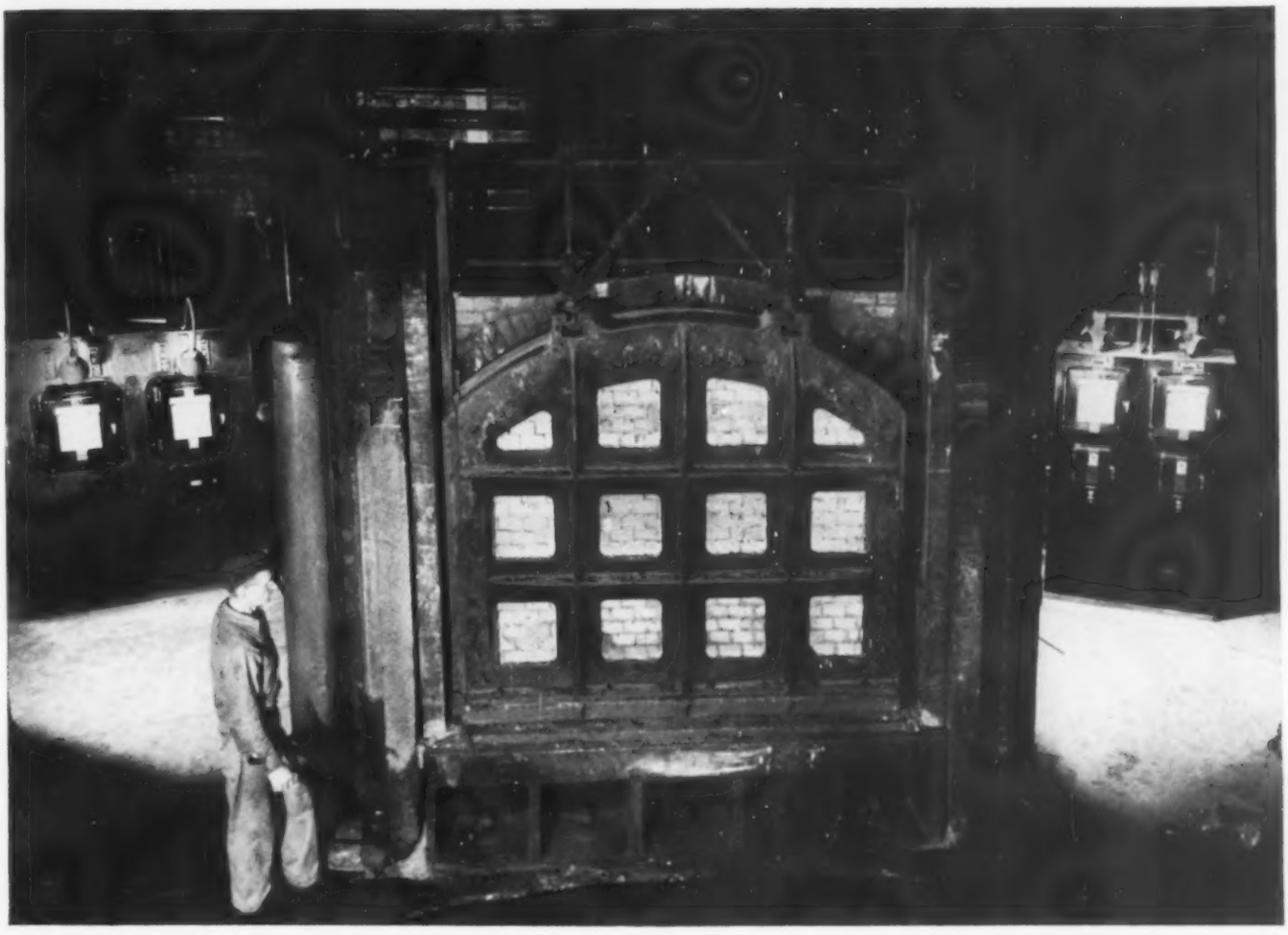
X-RAY



You Can "Forget" Temperature, Because Micromax Pyrometers Remember!

Micromax equipment has become a "natural" for heat-treating control because it's so completely independent of the user's attention — operates dependably, and at full sensitivity, under all plant conditions. Regardless of the product being heat-treated . . . forgings, castings, stampings or automatic screw machine work . . . a plant can take advantage of the toughness and flexibility of Micromax instruments. These features permit Micromax control to be installed where it will be the most useful . . . centralized, so that one operator can keep an eye on several furnaces, or right at the furnaces when desired.

Even if your plant does no heat treating, but uses materials or components heat-treated by suppliers, Micromax instruments in their plants can help obtain uniform high quality in your own product. Micromax control enables any heat-treater to do a better job, because he always has complete and accurate temperature information.

Our engineers are ready at all times to recommend the proper type of pyrometric equipment for any given service. Write to Leeds & Northrup Co., 4942 Stenton Avenue, Philadelphia 44, Pa.

Here Are Some Features

●Standardizing
A Micromax strip-chart instrument automatically standardizes itself.

●Ambient Temperature
A Micromax instrument compensates for all changes at the instrument.

●Supply Replacement
A Micromax instrument signals need for chart paper, ink and dry cells.

●Changes in Load
Micromax control maintains temperature in spite of fluctuations in size and weight of charge.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl Ad ND44-33-620(1)

Midwestern Steel Plant Cuts Lath Handling Man-Hours 85%

Transporter Brings Lath to Boxcar
Fifty bundles of lath, strapped to a skid, are brought to the boxcar for shipment. Load is moved on battery-operated platform Transporter, famed hand truck made by Automatic. Before, lath was carried manually in loads of ten bundles at a time.

Hand Trucks Team Up to Save Time and Lower Costs
Load of lath brought to boxcar by Transporter is taken over at that point by Transtacker, battery-operated stacking unit. Transtacker will tier loads of 50 bundles two high until both ends of the car are filled.

Car Loaded Quickly by Transtacker
Combined efforts of Transporter and Transtacker effect considerable reduction in materials handling time. Mechanized operation permits handling 1300 bundles of lath in six man-hours. Without machines, lath was loaded at the rate of 834 bundles in 40 man-hours. 85% reduction in handling time, 46% increase in volume loaded.

. . . Loads 46% more Lath with Automatic TRANSPORTERS & TRANSTACKERS

● *An 85% slash in man-hours despite a 46% increase in volume handled* was accomplished by mechanizing the lath handling methods in a large midwestern steel company.

Before the introduction of Automatic Transportation Company material handling equipment, the bundles of lath were transported around the plant manually. This involved moving them from the point where they were tied, to the warehouse, and eventually to the railroad siding where they were loaded by hand into the boxcar.

Using this technique throughout, the operation was slow and costly. In the boxcar loading phase, for example, a full eight-hour day was consumed while five men loaded 834 bundles of lath into the carrier.

When Automatic Fork Trucks, Transporters and Transtackers were put to work, 1300 bundles were loaded by the Transporter and Transtacker team . . . instead of five men working eight hours a day, or 40 man-hours—two men work three hours, or six man-hours.

The pictures on the left show and tell how this loading operation was handled. There is an Automatic Electric Truck for any and every steel operation. Send coupon for complete catalog of Electric Trucks suitable in your industry.

Trade Automatic Mark
ELECTRIC TRUCKS
Lighten LIFE'S LOADS

Trade Automatic Mark
47 W. 87th St., Dept. T-9, Chicago 20, Ill.
Please send me free Catalog describing Automatic Electric Trucks for handling steel and allied products.

Company Name .....
By ..... *Position* .....
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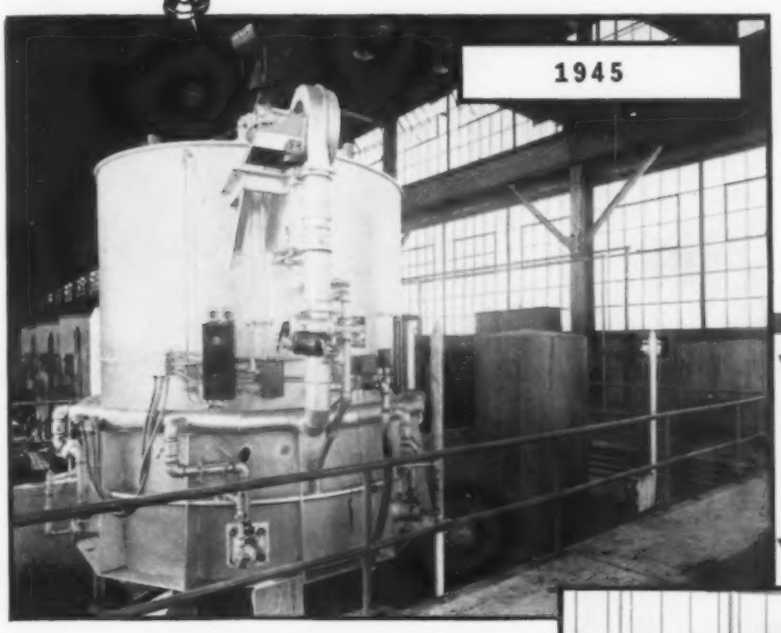
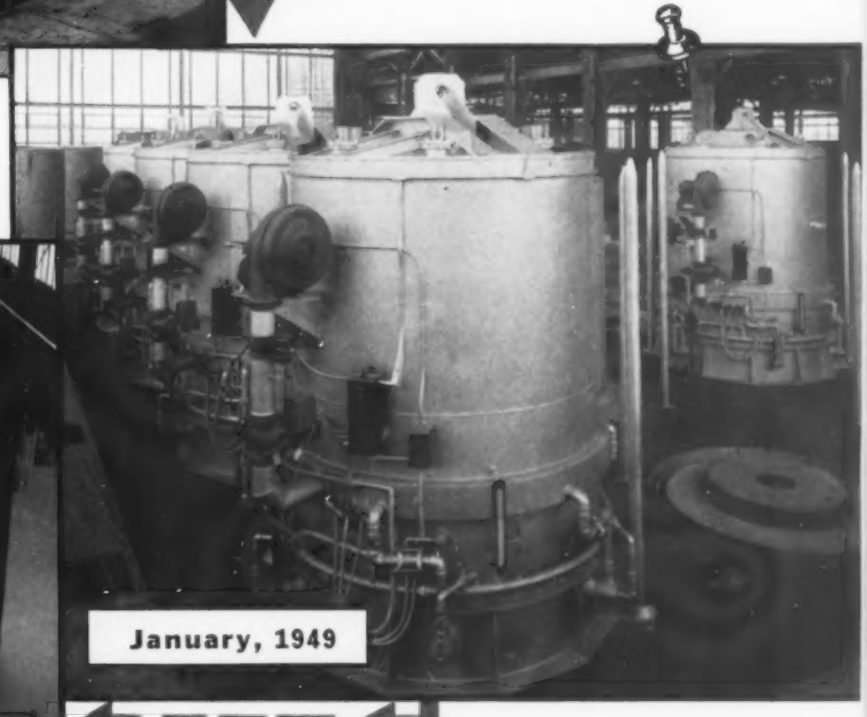
REPEAT ORDERS ARE POSITIVE PROOF OF *Lee Wilson* CONVECTOR FURNACE PERFORMANCE

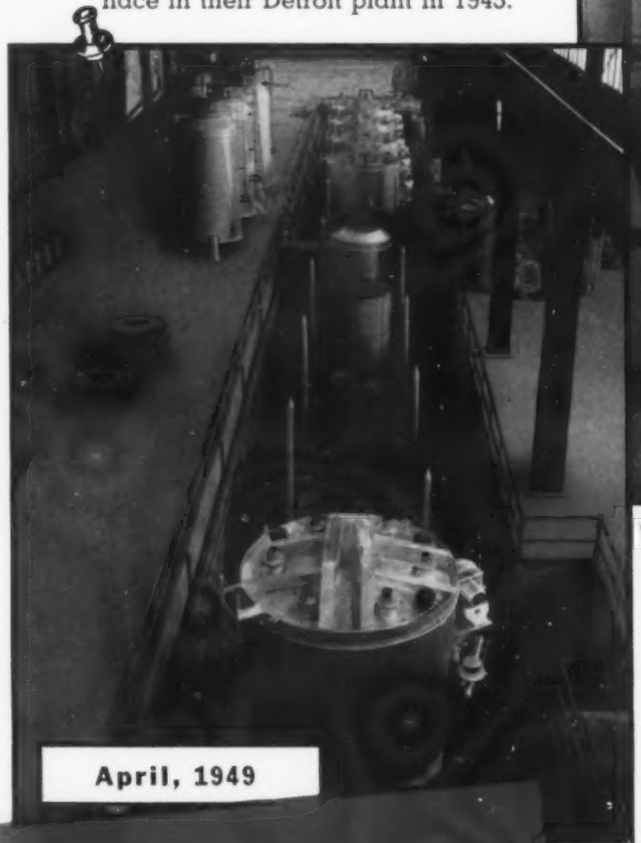


The Detroit Steel Corporation installed their first Lee Wilson radiant convector coil annealing furnace in their Detroit plant in 1945.

BASED ON the results from this first furnace, the management of the Detroit Steel Corporation installed Lee Wilson convector furnaces to take care of the requirements in their new plant at New Haven, Connecticut.

Five furnaces and 12 bases, capable of annealing 5000 net tons of low carbon strip coils per month, were put into operation in this plant in January 1949.





IN THE present modernization of the Detroit plant of this company, a duplicate of the New Haven installation was installed and began operation in April of this year. The first convector furnace indicated the tremendous economy of this design as measured in cost per ton per hour, which justified the selection of this equipment for the subsequent installations in both the New Haven and Detroit, Michigan, plants.

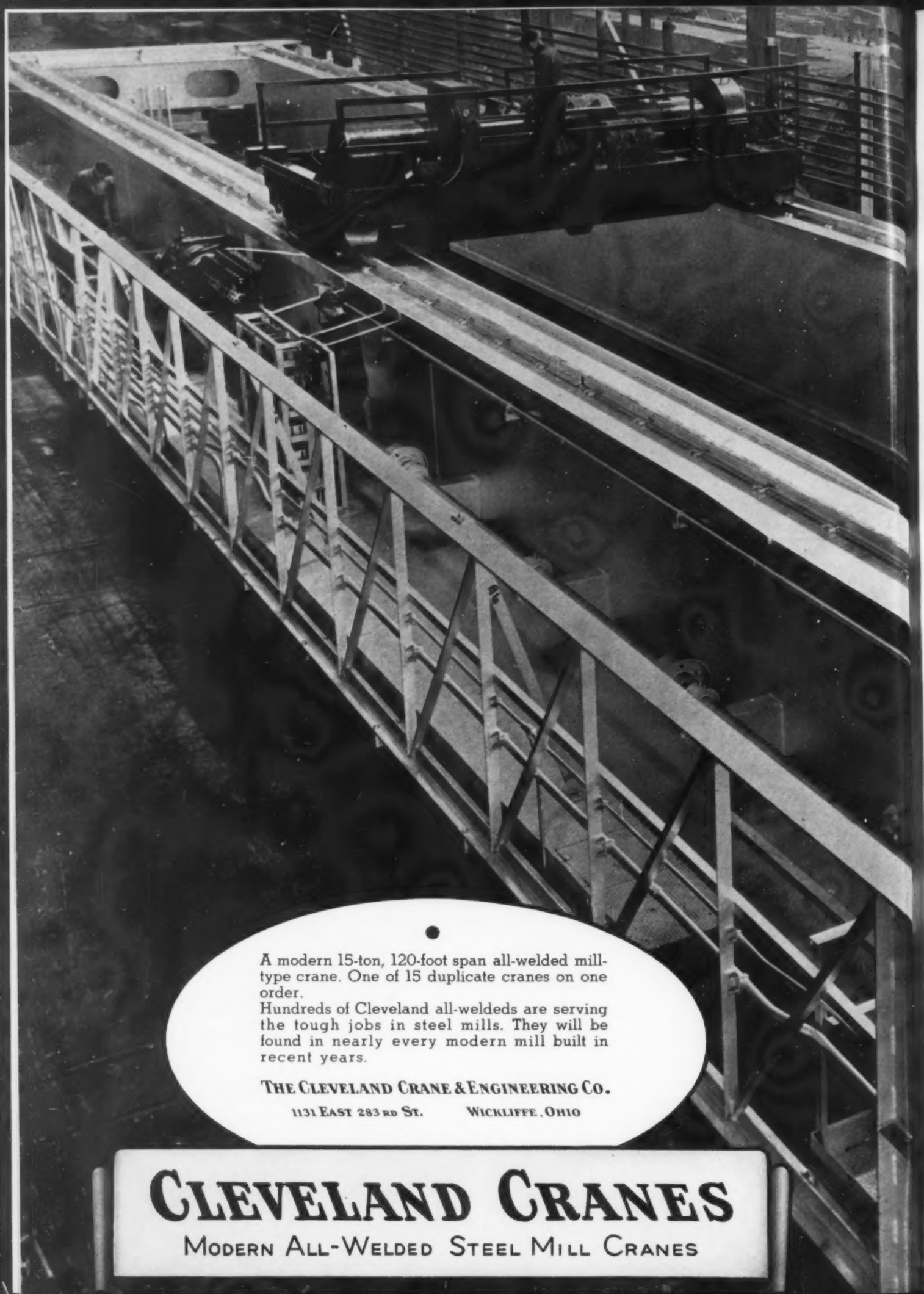
Lee Wilson

ENGINEERING *Co., Inc.*

20005 WEST LAKE ROAD • CLEVELAND, OHIO

Telephone ACademy 4670

INDUSTRIAL FURNACES • RADIANT TUBE HEATING • HEAT TREATING PROCESSES



A modern 15-ton, 120-foot span all-welded mill-type crane. One of 15 duplicate cranes on one order.
Hundreds of Cleveland all-weldeds are serving the tough jobs in steel mills. They will be found in nearly every modern mill built in recent years.

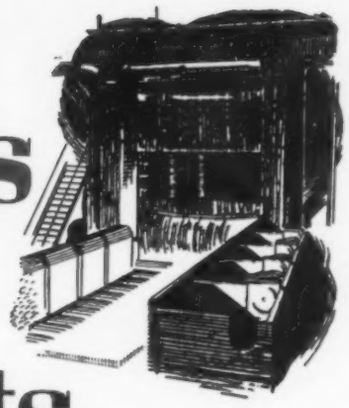
THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts



FINALLY, after truce, fact-finding, extensions and recriminations, Phillip Murray called out his United Steel Workers in what seems to be the most needless strike in our industrial history. The sole issue is whether or not the steel companies shall be forced now to agree that employers shall pay the entire cost of insurance, welfare benefits and pensions for employees.

The great majority of steel companies have offered to pay 4 cents per hour immediately for insurance and 6 cents per hour after study for pensions, as suggested by President Truman's fact-finding commission, if employees contributed smaller additional amounts.

Such plans would naturally result in higher benefits and pensions for workers, but Mr. Murray preemptorily rejected these offers as "wage cuts." He would accept the offers without the contributory condition, but he apparently believes that savings represent reduction in pay, and wants to deny his members the right to save. No doubt he also classifies deductions for government bond purchases as wage cuts.

No thinking person can deny that, for the overall good of everyone, some responsibility for an individual's old age must remain with the individual. Mr. Murray thought so when he approved the Social Security plan years ago. But now, poorly advised and overcome by envy of apparent gains by other labor czars, he has arbitrarily plunged the steel industry into a general strike — an unjustified strike that would not stand up under a referendum of his membership. In fact, so unpopular is the strike among steel workers in general that Mr. Murray felt it necessary to conduct a series of stump speeches through various steel-producing centers.

We are sure that the steel workers prefer to be working under the companies' new offers and saving some of their wages for their old age, rather than "doing and dying" on the picket lines for Mr. Murray's principle.

▲

THE 1949 AISE convention was held in Pittsburgh, October 3, 4, 5 and 6, as scheduled. Plans for this event were completed amidst strike deadlines, truces and near nervous breakdowns. It was planned that the convention would be postponed if a strike should come prior to September 26. When this date passed, it was decided that the convention would go on. We were betting on two points — first, that there might be no strike, and second, that a strike would not seriously hurt attendance. We lost on the first point, and won on the second.

The results were indeed gratifying. In spite of the adverse conditions, registered attendance was only 312 below the 1947 figure. Of course, the familiar faces of many convention regulars were missing. Most of these, according to their letters and wires, were on 24 hour call at their plants, but their places were partially taken by others who could come because the plants were down. All in all, the convention was voted a success, with good comments plentiful and complaints few.

▲

A DEFINITION of marriage: A committee of two on ways and means. One has her way, the other provides the means.

▲

A PAMPHLET recently came to hand, entitled TANSTAAFL and written by Pierre Dos Utt, sets forth a plan for a new economic world order. In logical manner, and with the graphic charts so dear to the hearts of economists, the pamphlet presents evidence of the economic ills of our nation and of the world, and follows through with a suggested remedy— one strong oligarchic nation, headed by a supreme triumvirate of labor leaders, controlling the world.

Actually, the pamphlet, which is patterned somewhat after the Nathan reports, is a clever burlesque. The derivation of its title may be found in the sentence: There Ain't No Such Thing As A Free Lunch. It was published by Cairo Publications, Canton, Ohio, in the belief that it will help to open peoples' eyes by emphasizing the ultimate destination toward which past and present events are carrying us. Certainly, if carefully read, it should do just that. Of course, there is always the danger that, carelessly read, the satire may be missed entirely, and the statements taken seriously. In fact, this has already happened in this case, with no lesser persons than a college president and a newspaper financial writer who called it "a most astounding and potentially dangerous treatise." However, we believe that the pamphlet can do much more good than harm, and we recommend it as entertaining (and enlightening) reading.

▲

A GEM of consistency is to be found in a remark by Robert N. Nathan, expert economist for the United Steel Workers, who said the country would be better off today if there had been "less expansion, less investment in 1947 and 1948, and more consumption."

▲

WE have previously commented in these columns upon "engineering by precedent" which is so common — perhaps too common — in industry. Recently we learned of another type of engineering — "engineering by suggestion."

One case in point involved air pressure which was claimed to be too low for riveting. Setting the hand ahead on the pressure gage and advising the workers that another compressor had been put on permitted riveting to proceed satisfactorily.

Another incident involved the use of oxygen in open hearth furnaces. All plans were made and equipment installed to run detailed tests to learn the results of the use of oxygen. Furnace production jumped 15 per cent without the introduction of any oxygen.

Our informant states that painting open hearth buckstays green will usually result in increased production.

Buried Skulls by the Acre—

Still the Cheapest Source for Heavy Melting Scrap

Every steel mill has its dump of skulls, buttons, and other metal-slag masses. Some are cinder coated. Some are so big they had to be buried to get them out of the way. These vast dumps contain treasures of usable metal that can become a valuable source of scrap. And now it is easy and economical to reduce this scrap to charging-box size.

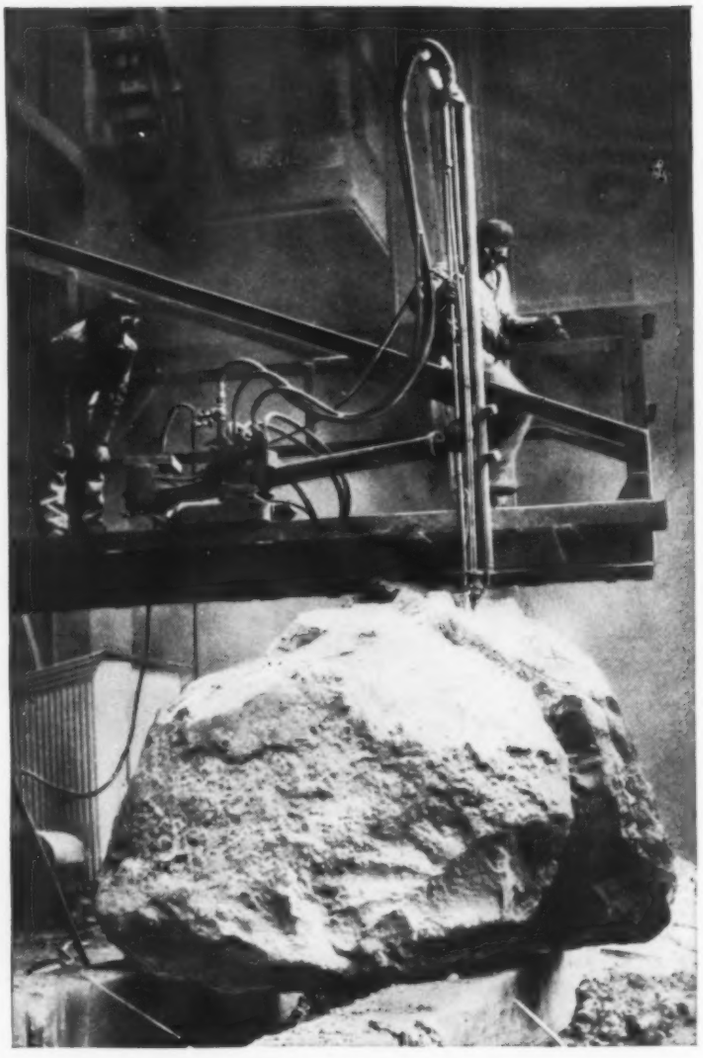
LINDE has devised a *new* blowpipe that is a practical and economical solution to the age-old, knotty problem of cutting skulls. Slag and cinder inclusions, tough-going for usual oxy-acetylene cutting, are no problem when the powder-cutting process is used with this new blowpipe—the OXWELD C-60.

The C-60 is big—to cut through thick sections. Masses of dirty steel six feet thick have been cut. Even thicker sections can be cut. No one yet knows its limits. It was built big for easy handling on irregularly shaped materials and for low cost operation. With a low-velocity oxygen stream, it cuts faster—as much as five to eight times faster—than the oxygen lance. The result is that the C-60 uses less oxygen per foot of cut than other methods such as oxygen lancing, and you save the cost of consumable lance pipe—which can run into money on big jobs. Nor is there a necessity for blasting apart the larger skulls and buttons.

Other Advantages of Powder-Cutting

Powder-cutting makes easy the cutting of the tough alloy steels, cast iron with its graphite inclusions, and bundle scrap with its gaps that hinder usual cutting methods.

★ LINDE can help you with your scrapping problems. For further information, please inquire at your nearest LINDE office.



Big cuts can be made with less oxygen when the OXWELD *C-60 Cutting Blowpipe is used. Here it is making a continuous cut through a steel button six feet thick.*

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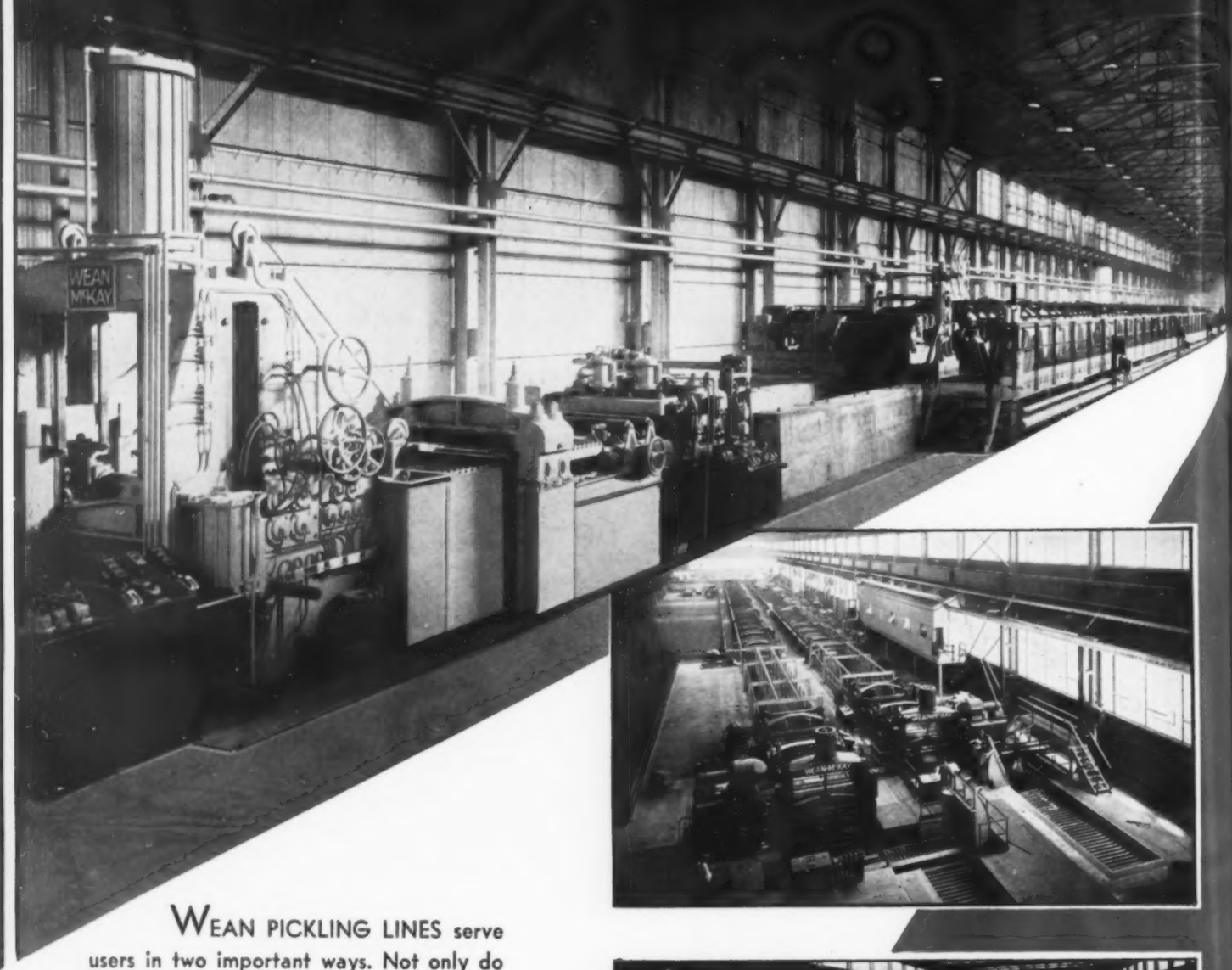

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Iron AND Steel ENGINEER

OCTOBER, 1949 VOLUME XXVI NUMBER X

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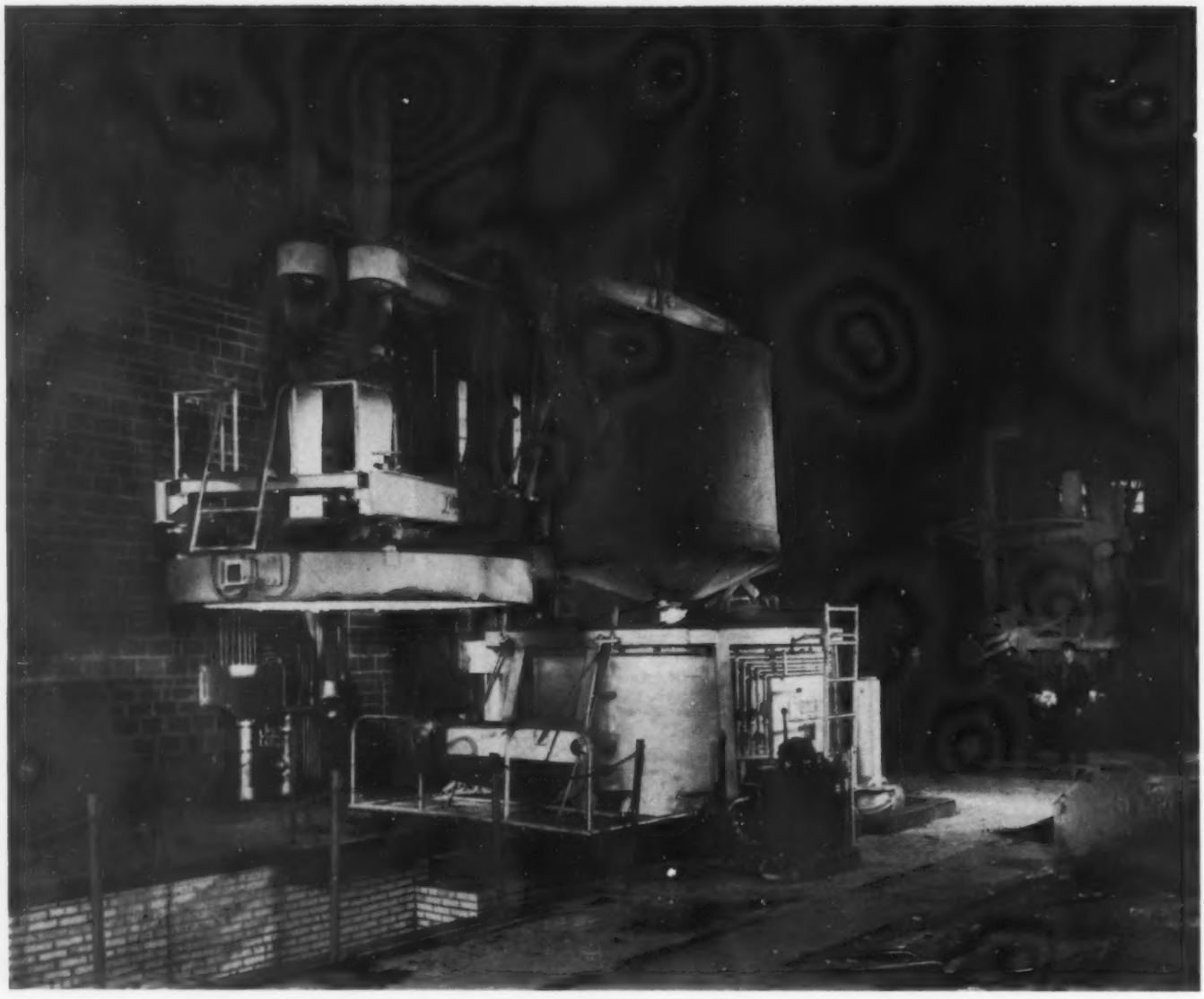

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Analytical and Experimental Studies OF LADLE HOOKS

By CARL W. MUHLENBRUCH
Associate Professor of Civil Engineering
Northwestern Technological Institute
Evanston, Ill.

. . . . the work reported in this paper describes a research project sponsored and financed by the Association of Iron and Steel Engineers as a part of its research and standardization program . . . final results appear as AISE Standard No. 7, Specification for Design of Ladle Hooks . . . .

▲ THIS investigation was an outgrowth of unsatisfactory experiences with ladle hooks in the various steel mills. Separation of the plates and more serious failures were considered to be too common for the period of use of the hooks. It was therefore felt that their design and performance should be investigated fully.

These studies were first initiated by the Association of Iron and Steel Engineers in correspondence with Professor H. A. Thomas of the Department of Civil Engineering of the Carnegie Institute of Technology, Pittsburgh, Pa., in July of 1943. In June of 1945 the investigation was turned over to the author who originated and completed the experimental studies and analysis presented in this report.

The original scope and objectives of this investigation were four-fold as follows:

1. To prepare an analytical study of ladle hooks to determine from a design standpoint any peculiarities which they might exhibit and any unusual details of materials or fasteners which they might require.
2. To investigate the fastening problem in ladle hooks to determine whether the method and technique of fastening, or the type of applied load might in any way influence their service behavior.
3. To perform field tests of several types of ladle hooks in an effort to determine if unsuspected operating conditions might be causing some of the service failures.
4. To determine the best design procedure for ladle hooks.

Presented before AISE Annual Convention, Cleveland, Ohio, September 28, 1948

After the first field test was made it became apparent that objective C was the most important.

The testing work done in connection with the riveted joints was carried out in the materials testing laboratory of the Carnegie Institute of Technology, Pittsburgh, Pa., while the author was associate professor of civil engineering in that school.

Acknowledgment is due to the American Bridge Co., which furnished the material for the test specimens and drove all of the hot rivets; the Pittsburgh Screw and Bolt Corp. and Riveting Apparatus, Inc., which furnished all of the rivets and drove all of the cold-driven rivets; the Weirton Steel Co., which cooperated in making field tests of ladle hooks; and the Morgan Engineering Co., which adapted suggestions made by Professor Thomas to several ladle hooks being built for the Weirton Steel Company.

PLAN OF INVESTIGATION

A preliminary investigation of the problem and several discussions with the users of ladle hooks seemed to indicate that the entire investigation would resolve essentially around the fasteners used. It therefore was necessary to determine the amount of "slip" or distortion which might be expected from various types of riveted joints using various kinds of rivets. The possibility of combining the rivets with welding was also considered worth investigation.

Since one of the first evidences of failure observed in ladle hooks was the separation of the plates making up the hooks, it became necessary to determine the influence of various types of rivets and methods of driv-

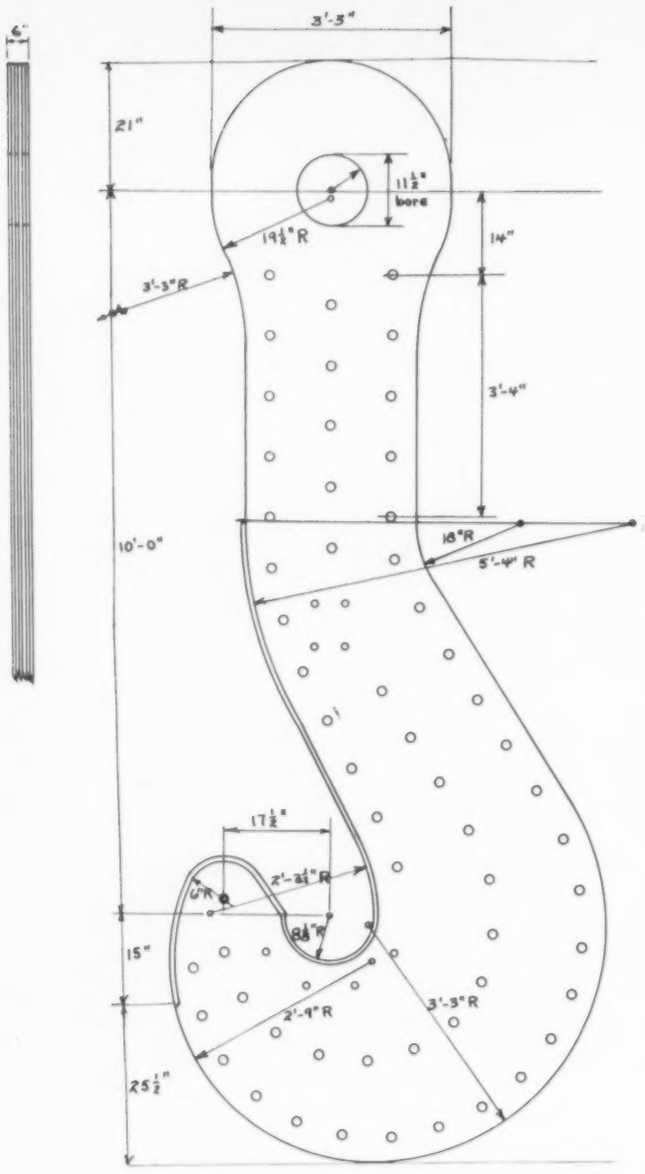


Figure 1 — Stresses were measured in the open hearth shop on the hook shown in this drawing.

ing upon the load-slip characteristics of a riveted joint. Specimens were designed to permit the determination of minute distortions since even the smallest amount of distortion, particularly if it is permanent, may forecast the beginning of final failure of the connection. The specimens were made sufficiently large so that the grip range of the rivet was reasonably similar to that of the average ladle hook.

It was also considered advisable to investigate the effect of a small number of repeated loads upon the subsequent static load-slip characteristics of a riveted connection. Existing data shows the effect of repeated loading upon the ultimate strength of a riveted joint (1) * and some studies have been made which show the effect of slip during repeated applications of load (1). No tests were found, however, in which loads equivalent to the working stress of the joint were applied a small number of times and then the specimen was studied for load-slip characteristics under static load. It seems likely that once initial slip has taken place, the movement of the plates will continue rapidly, particularly under repeated loading. This may lead to loosening of the connection or actual failure under repeated loading.

It was anticipated that the rivet studies, together with the studies of welds, would lead to a decision regarding the type of fastener which should be used. With this in mind the studies were planned to provide quantitative data which would permit such an evaluation. It will be shown, however, that the importance of the fasteners was minimized after the first field tests were made.

Studies of riveted joints conducted by others (2) have shown that the initial grip of the hot-driven rivet is the most important single factor contributing to its ability to resist slip when under load. Once this initial grip is overcome, considerable and sometimes violent, slip is encountered and the plates of the connection move sufficiently to engage the shank of the rivet in shear. This condition prevails throughout the remainder of the usable range of the connection and up to the ultimate load which the joint is able to sustain. The movement due to initial slip in the joint is of paramount importance because once this slip has taken place it will continue at a more rapid rate until the joint becomes loose or until failure by fatigue occurs. The initial grip specimens were designed to permit a quantitative evaluation of the magnitude of the initial grip.

It had originally been planned to investigate in the field a new hook which would be intact because of its short period of service and also an old ladle hook which had been in service long enough to show signs of distress. Fortunately one of the crane companies was designing several hooks for the Weirton Steel Co. when this investigation was begun. At the suggestion of Professor H. A. Thomas, two hooks were designed which differed only in that one was not welded while the other had continuous welding around the bottom of the hook from a point 15 in. above the bight together with skip welding along the shank. Because the case history of these hooks was known in complete detail, they were studied and no attempt was made to perform load tests of an old hook.

A preliminary investigation based upon a canvass of users of ladle hooks indicated that temperatures in excess of 550 F would not be encountered in hooks used to raise a ladle full of hot metal. Estimates ranged from 200 F to 450 F. It was realized that if the higher value was correct, the temperature stresses in the hook would be large. Due to the fact that the heat was applied from one side of the hook only, it was likely that the pseudo load thus applied to the outside plate might set up a high enough stress differential between this outside plate and the second plate to break the initial grip of the rivets and thus start delamination. Since the strain in steel resulting from a temperature differential of only 100 F is 0.0005 in. per in. and the corresponding stress is 15,000 psi, it can be seen that the temperature effect is extremely important.

A detailed analytical study of ladle hook design is not necessary in this report. Other investigators have developed clearly formulated design relationships. An

*Numbers in parentheses refer to bibliography.

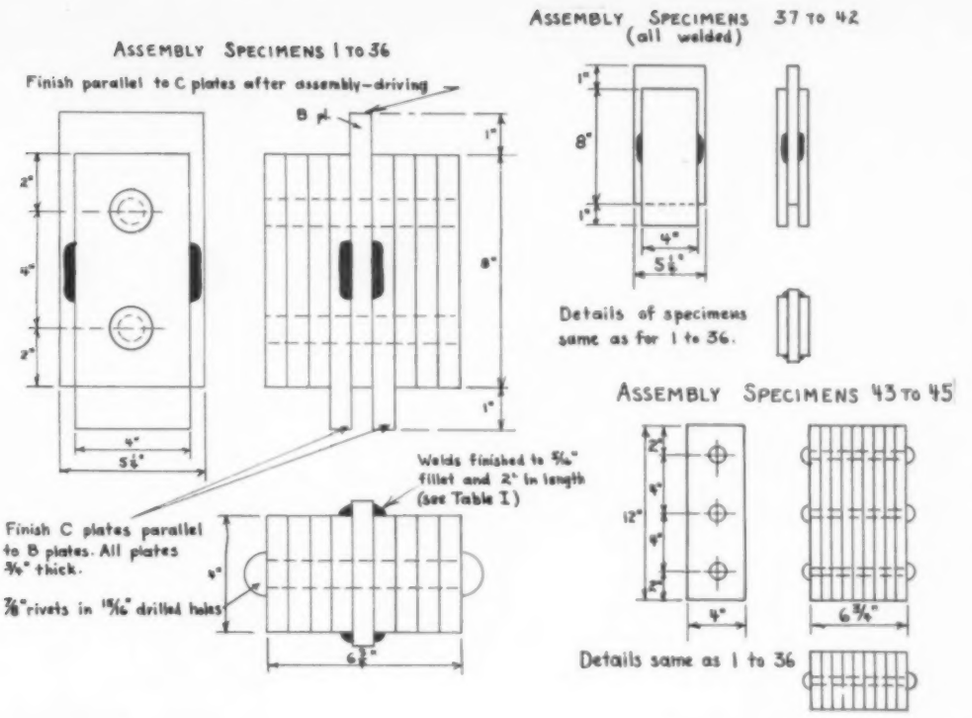
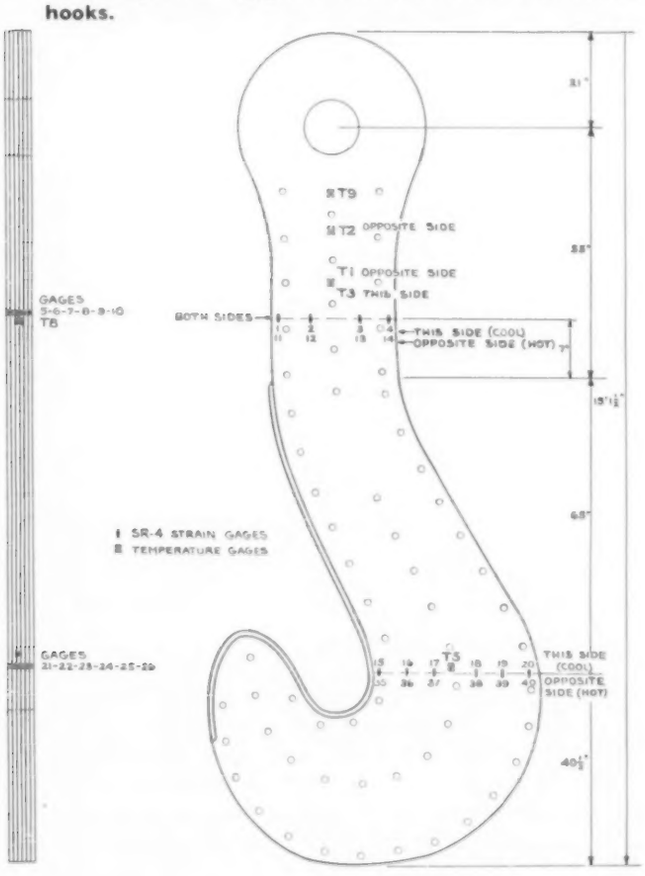

ASSEMBLY SPECIMENS 1 TO 36
Finish parallel to C plates after assembly-driving
B pl.
Finish C plates parallel to B plates. All plates ¾" thick.
⅞" rivets in 15/16" drilled holes
Welds finished to ⅝" fillet and 2" in length (see Table I)
ASSEMBLY SPECIMENS 37 TO 42 (all welded)
Details of specimens same as for 1 to 36.
ASSEMBLY SPECIMENS 43 TO 45
Details same as 1 to 36

Figure 2 — Specimens were made as indicated in the drawing to study the behavior of riveted joints.

investigation (3) conducted by F. K. Chang, K. E. Knudsen and B. G. Johnston in the Fritz engineering laboratory at Lehigh University may be referred to in this respect.

The critical dimensions of the hooks tested are given in Figure 1. All rivets were countersunk, ⅞ in. in diameter, and were driven in $^{15}/_{16}$ in. holes. The unwelded hook was made up of six 1 in. thick plates. The welded hook had ¾ in. thick outside plates and four 1⅛ in. thick inside plates, a total of six. Both hooks were 6 in. thick. The two hooks differed only in the location and amount of welding. The unwelded hook had no structural welds and had been placed in service the day prior to making the field tests. The welded hook employed skip welding along the shank and continuous welding around the bottom of the hook and had been in use approximately six months prior to testing.

Figure 3 — The sketch shows the location of the strain and temperature gages in the field test of the actual hooks.



For a direct axial load, P, applied along the ladle shank the transverse tensile stress, s_{sh}, will be uniform and equal to

$$s_{sh} = \frac{P}{A} = \frac{P}{28 \times 6} = \frac{P}{168}$$

where A is the gross shank area. Considering the rivets in the cross-section to be so placed that the loss of area is equivalent to 3 rivet holes gives

$$s_{sh} = \frac{P}{168 - (\frac{7}{8} \times 6)\,3} = \frac{P}{152.2}$$

For each 100,000 lb of hook load the shank stress will be 656 psi.

From equation (8) of the photoelastic studies conducted at Lehigh University (3)*, the maximum stress at the inside fibers of the bight will be

$$s_b = K_t\ (P/A + Mc/I)$$

in which

s_b = maximum stress on inside fibers of bight a distance c (in.) from the centroidal axis, psi
c = one-half section width, in.
P = applied load, lb
A = cross-sectional area, sq in.
M = bending moment at section, in. lb
I = moment of inertia of cross-section, in.^{4}

*From reference 4 in Lehigh paper (T. J. Dolan and R. E. Levine, "A Study of Stresses in Curved Beams," *Proceedings of the Thirteenth Photoelasticity Conference*, pp. 90-97, 1941). Additional references to other analytical and experimental studies of stresses in hooks are given in the bibliography for the photoelastic studies (3).

TABLE I — RIVETED JOINT TEST RESULTS

Specimen number	Type of rivet (⅞ in. diameter rivets — 6¼ in. grip)	Type of loading	Working stress, psi	Slip load, lb	Average slip at working stress, in.	Average slip at 150 per cent of working stress, in.	Maximum shearing stress, psi
1	A141-39, hot driven	Static	12,000	28,800	0.00021	0.00047	50,800
2	A141-39, hot driven	Static	12,000	28,800	0.00011	0.00027	50,400
3	A141-39, hot driven	Static	12,000	28,800	0.00016	0.00031	49,500
Average					0.00016	0.00035	50,250
4	A141-39, hot driven	Repeated	12,000	28,800	0.00039	0.00063	50,500
5	A141-39, hot driven	Repeated	12,000	28,800	0.00017	0.00035	50,450
6	A141-39, hot driven	Repeated	12,000	28,800	0.00031	0.00053	50,000
Average					0.00029	0.00050	50,300
7	A141-39, hot driven and welded	Static	12,000 (rivets)	48,000	0.00033	0.00078	40,400
8	A141-39, hot driven and welded	Static	and	48,000	0.00018	0.00062	39,200
9	A141-39, hot driven and welded	Static	9,100 (welds)	48,000	0.00023	0.00057	38,800
Average					0.00025	0.00066	39,450
10	A141-39, hot driven and welded	Repeated	12,000 (rivets)	48,000	0.00031	0.00067	38,500
11	A141-39, hot driven and welded	Repeated	and	48,000	0.00032	0.00062	38,620
12	A141-39, hot driven and welded	Repeated	9,100 (welds)	48,000	0.00024	0.00041	43,050
Average					0.00029	0.00057	40,100
13	A195-39, hot driven	Static	15,750	37,800	0.00034	0.00082	76,500
14	A195-39, hot driven	Static	15,750	27,800	0.00034	0.00118	75,600
15	A195-39, hot driven	Static	15,750	37,800	0.00038	0.00063	71,500
Average					0.00035	0.00088	74,500
16	A195-39, hot driven	Repeated	15,750	37,800	0.00044	0.00058	74,800
17	A195-39, hot driven	Repeated	15,750	37,800	0.00047	0.00059	69,550
18	A195-39, hot driven	Repeated	15,750	37,800	0.00022	0.00048	76,500
Average					0.00038	0.00055	73,600
19	A195-39, hot driven and welded	Static	15,750 (rivets)	57,000	0.00049	0.00100	49,900
20	A195-39, hot driven and welded	Static	and	57,000	0.00039	0.00080	52,000
21	A195-39, hot driven and welded	Static	9,100 (welds)	57,000	0.00045	0.00103	50,750
Average					0.00044	0.00094	51,000
22	A195-39, hot driven and welded	Repeated	15,750 (rivets)	57,000	0.00016	0.00041	49,300
23	A195-39, hot driven and welded	Repeated	and	57,000	0.00032	0.00060	50,400
24	A195-39, hot driven and welded	Repeated	9,100 (welds)	57,000	0.00025	0.00056	38,600
Average					0.00024	0.00052	45,100
25	A141-39, cold driven	Static	12,000	28,800	0.00149	0.00270	46,800
26	A141-39, cold driven	Static	12,000	28,800	0.00118	0.00271	47,050
27	A141-39, cold driven	Static	12,000	28,800	0.00090	0.00195	46,520
Average					0.00119	0.00245	46,800
28	A141-39, cold driven	Repeated	12,000	28,800	0.00062	0.00126	46,500
29	A141-39, cold driven	Repeated	12,000	28,800	0.00119	0.00288	46,800
30	A141-39, cold driven	Repeated	12,000	28,800	0.00095	0.00266	48,520
Average					0.00092	0.00227	47,270
31	A141-39, cold driven and welded	Static	12,000 (rivets)	48,000	0.00047	0.00106	40,530
32	A141-39, cold driven and welded	Static	and	48,000	0.00105	0.00281	37,550
33	A141-39, cold driven and welded	Static	9,100 (welds)	48,000	0.00056	0.00103	38,900
Average					0.00069	0.00163	39,000
34	A141-39, cold driven and welded	Repeated	12,000 (rivets)	48,000	0.00044	0.00106	41,300
35	A141-39, cold driven and welded	Repeated	and	48,000	0.00054	0.00099	42,200
36	A141-39, cold driven and welded	Repeated	9,100 (welds)	48,000	0.00030	0.00066	43,000
Average					0.00043	0.00090	42,130
37	None, welded only	Static	9,100	19,200	0.00033	0.00060	43,860
38	None, welded only	Static	9,100	19,200	0.00030	0.00053	45,060
39	None, welded only	Static	9,100	19,200	0.00020	0.00038	44,800
Average					0.00028	0.00050	44,500
40	None, welded only	Repeated	9,100	19,200	0.00023	0.00037	44,650
41	None, welded only	Repeated	9,100	19,200	0.00023	0.00043	50,500
42	None, welded only	Repeated	9,100	19,200	0.00035	0.00036	48,930
Average					0.00027	0.00039	48,000

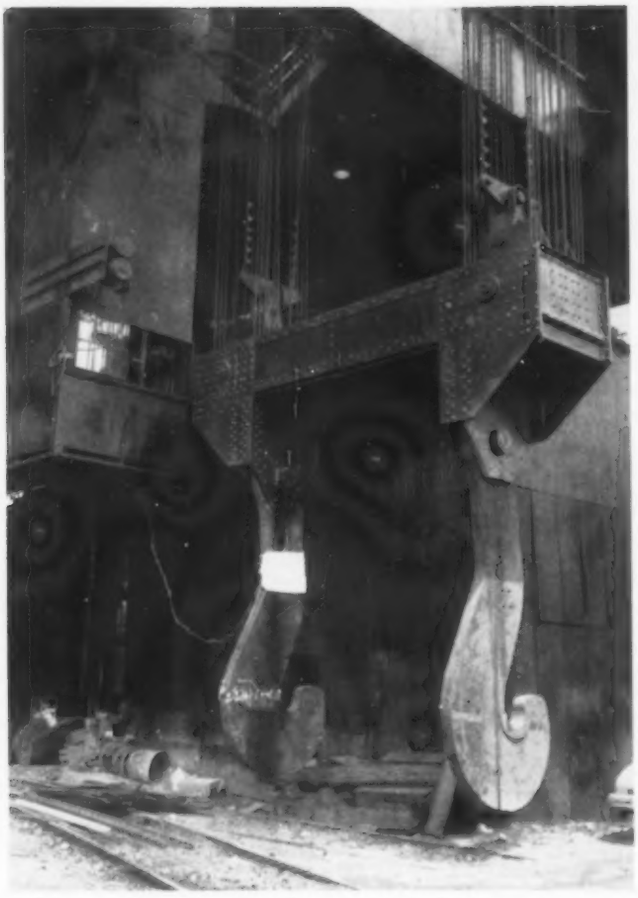


Figure 4 — The unwelded hook is shown ready for field tests.

$$K_t = \frac{2-\alpha(R/c-1)}{3(R\alpha/c-2)\ (R/c-1)}$$

(Values of K_t are given in Table I of Ref. 3)

$$\alpha = \log_e\left(\frac{(R/c)+1}{(R/c)-1}\right)$$

R = Distance from centroid of section to point of application of load, in.

Since R = 27.13 in. and c = 19.13 in. the value of K_t for the hooks will be 2.06. The theoretical analytical stress distribution across the bight of the hooks for the actual applied loads will be shown by comparison with the observed stresses.

MATERIALS AND TEST SPECIMENS

The details of the riveted joint specimens are given in Figure 2. A description of the type of rivet used and other details regarding the specimens will be found in Table I. This table indicates those specimens which were riveted only, welded only or riveted and welded.

It may be seen from Figure 2 that all of the specimens except the welded ones were made up of $\frac{3}{4}$ in. thick plates assembled to give a grip length of $6\frac{3}{4}$ in. or an L/d ratio (length to diameter) of 7.71. The specimens were made by clamping the plates into position and drilling $1\frac{5}{16}$ in. holes through all plates at one time. Plates which were to be riveted were held in place with a single bolt until one rivet had been driven. Specimens in which welds were combined with rivets were welded prior to riveting. All hot driving was done with an air operated yoke type riveter. The pressure was left applied to hot-driven rivets until they had cooled to a temperature below the lower critical. Cold-driving was performed with an air powered yoke type riveter fitted with a modified control to permit controlled driving.

The material in the plates of all test specimens conformed to A. S. T. M. designation A 7-46, "Structural Steel for Bridges and Buildings." The various rivet stocks conformed to the A. S. T. M. designations given in Table I. Rivets were cut from a continuous length of bar stock so that they would be as much alike in physical characteristics as possible. All rivets for cold-driving were cold-made since the author has found in other studies that this type is superior to the hot-made rivet for cold-driving. The other rivets were hot-made.

All welds were overfilled and then finished in a shaper to a $\frac{5}{16}$ in. fillet. The 2 in. length was obtained by trimming the ends of the weld in an end mill.

Specimens 37 through 42 were welded only and consisted of three plates as shown in Figure 2. Obviously there was no need for fill plates in this type of specimen.

The specimens designed to determine the initial grip of the rivets, 43 through 45, were fabricated with the center rivet driven first followed by the end rivets. In order to determine the initial grip of the rivets, each specimen was cut into three parts, each part containing one rivet. The heads of the rivets were then turned flat and parallel, and the overall length with the filler plates in place was determined with a dial indicator

Figure 5 — Closeup of hook shown in Figure 4. The gages across the shank are protected with asbestos cloth. The gages immediately under the bale are temperature indicating gages.

Figure 6 — Closeup of gages across bight of hook. The dummy gages which are fastened to small steel plates are indicated by arrows and the active steel gages are circled. The adhesive shown, scattered haphazardly across the hook, was used primarily to keep the wires close to the hook.

reading to 0.001 in. After this initial measurement the specimen was gripped in a lathe and the plates turned off the rivet shank. In the hot-driven specimens all of the plates were loosened after one plate had been completely removed from the shank. Because of the greater wall pressure in the cold-driven specimens it was necessary to remove all of the plates for this type of rivet.

METHOD OF TEST

Compression type riveted joint specimens were used in these tests and were supported on a 2 in. thick flat plate on the weighing table of the testing machine. Load was applied through a spherical bearing placed atop a solid steel plate resting on the shear plate of the test specimen. Static load tests were performed in a 150,000 lb testing machine reading to 10 lb. Load was applied at a rate of 0.02 in. per minute speed of travel of the cross-head of the testing machine. Tension tests of the rivet stock and the plate material were made in a hydraulic testing machine of 60,000 lb capacity. Stress-strain relationships were obtained with an automatic-autographic electrical extensometer.

Slip of the shear plate with respect to the bearing plates was determined with four dial indicators, reading directly to 0.0001 in., on both sides of the specimen corresponding to the driven head and the manufactured head. The two positions of measurement on each side of the specimen were referred to as side A or side B. Thus two measurements were taken on the driven head end of the rivet corresponding to side A and side B. The dial indicators were adjusted to zero at a true zero load and were read at load increments of 2500 lb in the elastic range and 5000 lb in the plastic range. Loading increments of 5000 lb and 10,000 lb were used for specimens which were welded and riveted. Application of load was continuous between readings but was discontinued while the readings were being taken. In the case of the hot-driven rivets, the load was applied until violent slip had occurred or until sufficient plastic distortion had been observed. In the former case the gages were jarred so severely that the resulting reading had no value. Load was applied to the cold-driven specimens until the rivet material was well into the plastic range.

Inasmuch as only 300 repetitions of load were to be applied to each repeated loading specimen, the cycles were carried out in an ordinary testing machine. A 60,000-lb hydraulic type testing machine was used for this work. Specimens were placed in the machine in the same manner as for the static compression tests and load was alternately applied and released with the controls of the testing machine. By this method it was possible to complete one cycle of a load equivalent to the normal working stress in the rivet shank in 15 seconds or four per minute. The specimens which were subjected to repeated loading may be noted from Table I. This table also shows the magnitude of the repeated unit stress set up in the rivet shank or in the combination of the rivet shank and weld metal.

Stresses were obtained in the field tests with SR-4 electrical type strain gages. Strains were read with an SR-4 portable type strain indicator which permits direct determination of strain in micro-inches (0.000001 in. per in.).

In the first field test, which was performed on the welded hook, no attempt was made to correct each strain gage for localized temperature conditions since it was anticipated that the correction could be made from the temperature gages. Since the first test showed that this method might not yield the best data, appropriate steps were taken in the test of the unwelded

Figure 7 — Welded hook ready for test. The small fiber plates used to cover the temperature gages can be seen in the upper part of the hook.

hook to isolate temperature strains. This was done by fastening a dummy gage adjacent to the active gage in point. Strains were then measured for the active gage and the dummy gage, the algebraic sum being used to determine the true strain at the point. Dummy gages were made up by applying the SR-4 strain gages to ¼ in. thick plates of steel 4 in. long and 2 in. wide, and having the same coefficient of thermal expansion as the material in the ladle hook plates. These temperature correcting dummy gages were mounted in such positions that they served three gages on the hot side of the ladle hook and positions along the edges of the hook from the hot side to the cool side.

The location of all strain and temperature gages is shown in Figure 3. The test set-up used in the field

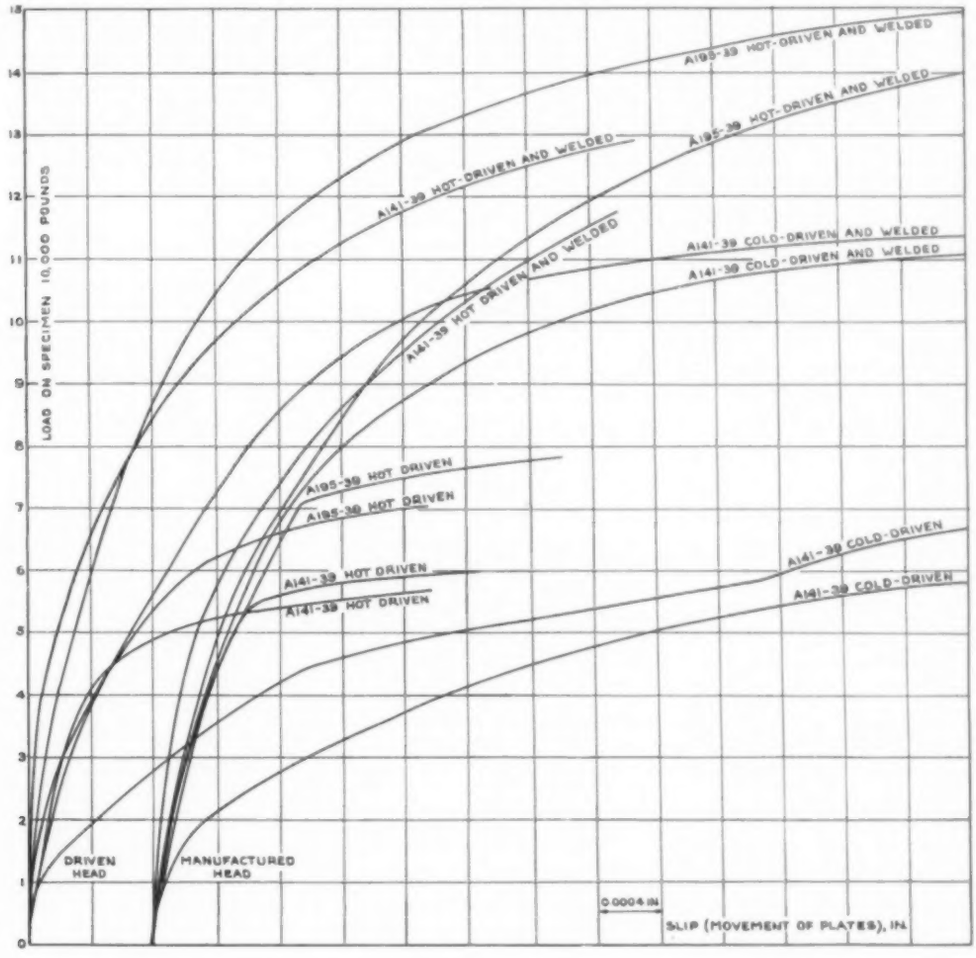


Figure 8 — Characteristic load-slip diagrams for various types of riveted joints under test are given in the graph.

fiber, which may be seen in Figure 7, was placed over gage T 2 to insulate it. After the test was underway this insulating strip caught fire and in turn set fire to the plastic coating on the lead wires. This shorted out the lead wires and prevented additional readings. Because of this difficulty the lead wires were wrapped with asbestos tape for a length of approximately 3 ft to prevent a reoccurrence in the test of the unwelded hook (the second test).

In the test of the welded hook the initial readings were obtained with an empty ladle freely supported by the hook and after the ladle had been filled with 204 tons of hot metal. It required approximately 10 minutes to read all of the strain gage lines. During this time interval, the ladle had been moved into position for studies for both the welded and unwelded hooks is shown in Figures 4 through 7. In Figure 5 it may be seen that all of the lead wires to the gages were assembled into one cable and carried to the control cab of the crane. At this point they were placed through properly identified holes in a control board so that the gages could be read rapidly once the ladle was full of hot metal.

Temperature gages consisted of chromel-alumel thermocouples fitted through two-holed porcelain leads. Inasmuch as temperatures higher than 550 F had not been anticipated in the test of the welded hook, the thermocouple wires were carried through a 3 in. long two-holed porcelain insulator and thence to plastic covered lead wires. At the time of the test a piece of teeming and approximately 6 ingots had been teemed. The amount of metal thus removed from the ladle did not constitute more than 12 per cent of the total 204 tons maximum load and therefore has not been considered in presenting the data. Temperatures were read at regular time intervals beginning with the instant that the tap was completed and the ladle was full.

In the test of the unwelded hook, the initial stresses were obtained with the hooks hanging freely and with no load other than their own weight. The strain gages were then read with a 65-ton ladle and 200 tons of hot metal in place. Although more temperature gages and strain gages were used in this test, approximately the same amount of testing time was required as for the welded hook.

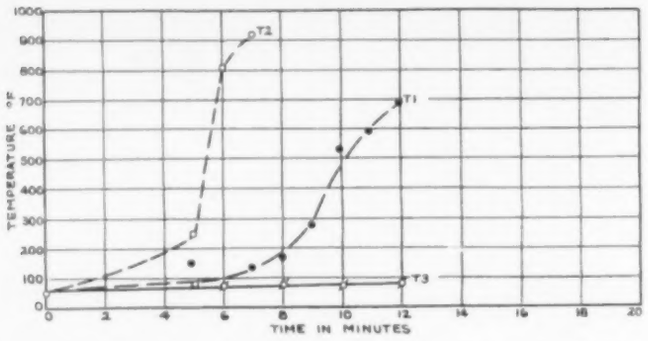


Figure 9 — The graph shows the increase in temperature in the welded hook from the time the hot metal is poured into the ladle.

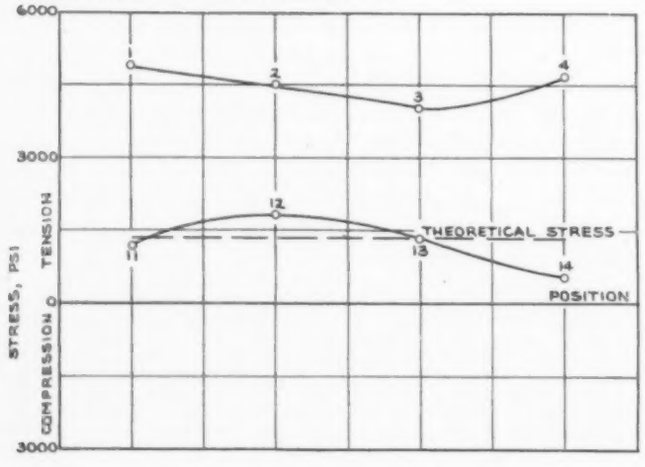
TEST RESULTS — RIVETED JOINTS

The results of the riveted joint tests are summarized in Table I. Characteristic load-slip diagrams for the specimens are shown in Figure 8. It should be noted that the term "slip," as used in the table and figure, includes the compressive strain in the plates of the specimen as well as the actual relative movement of the plates.

From the load-slip diagrams, an important characteristic difference between the action of hot and cold-driven rivets is apparent. This is the tendency for the hot-driven rivet to resist slipping of the plates of the joint due to the initial grip of the rivet. This permits a hot-riveted joint to act elastically, to all external appearances, up to that load at which the initial grip is overcome. At this load the slip is sudden and often violent. In some specimens in these tests, the sudden slip was so violent that the slip indicating gages were jarred sufficiently to prevent obtaining additional data. Some of the hot-driven specimens did not slip violently indicating less initial grip than those which did. This variation in initial grip is quite common in hot-driven rivets. It is also important to note that the rivets used in the rivet studies had round heads in contrast to the countersunk type of head which is necessary in the actual ladle hook. The round type of head was employed because it was easier to fabricate the specimens, and because it was felt that this type of head would yield more consistent data than the countersunk type.

Further study of Table I (or the load-slip diagrams) indicates that the cold-driven specimens had slipped more at a stress equivalent to 12,000 psi shear in the rivet shank than had the hot-driven specimens. This is normally due to the fact that the cold-driven rivet resists movement of the plates because of actual shear of the rivet shank as is assumed in normal design procedure. By comparison with other studies conducted by the author, however, the slip of the cold-driven specimens was considered to be excessive. It was found upon investigation that the drilled holes in the specimen plates were approximately $\frac{1}{32}$ in. over-size and had a few galleries which possibly might not have been filled during the upsetting of the rivet shank. It was also found that the metal in the cold-driven rivets was decarburized on the surface to a depth of 0.002 in. maximum. The author feels that the combination of these two circumstances resulted in the comparatively large slip observed for these specimens. Similar studies made by the author for specimens having a ratio of grip length to diameter of 6.0 indicate that the slip for properly made cold-driven specimens would be approximately 30 to 35 per cent less than that shown in the load slip diagrams included in this report. The distortion in a hot-driven joint is less than that in a cold-driven joint up to the point of sudden slip of the hot-driven rivet. Beyond this point, the hot-driven rivet slips rapidly and eventually more than the cold-driven rivet. A comparison is made in Table I not only for the slip at the working stress but also at a stress equivalent to 50 per cent more than the working stress to show that the magnitude of the slip increases rapidly beyond the point of initial slip.

Figure 10 — Graph shows the difference between the observed and theoretical stress in the shank of the welded hook. No stresses due to transverse bending are included in these values.



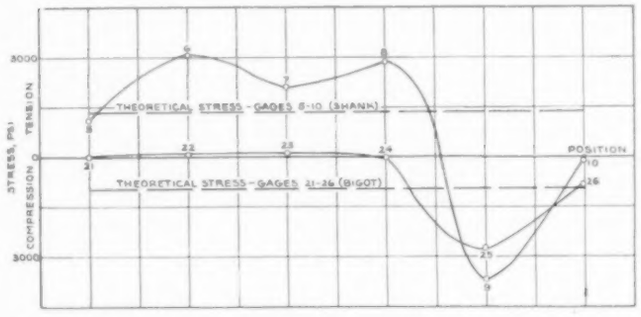


Figure 11 — The observed and theoretical stresses for the back edge of the shank and the bight, uncorrected for transverse bending, are given for the welded hook.

It may be noted from Table I that the combination of riveting and welding appears to be advantageous. The slip at a unit stress equal to the sum of the shearing stress in the rivet shank end in the weld metal is not much greater than the slip observed for the load which sets up the same unit shearing stress in the rivet shank alone. It should be pointed out, however, that one of the difficulties of combining welding and riveting is the possibility of reducing the initial grip of a hot-driven rivet due to the heat of welding and also the possibility of setting up internal stresses if the welding operation follows riveting.

One of the most important evidences to be observed from the rivet studies is the effect of 300 repetitions of a working load upon the strength of hot-driven riveted joints. It may be seen from Table I that the average slip at the working stress for the A 141-139 hot driven rivets subjected to static load was 0.00016 in. After 300 repetitions of the load required to set up a unit shearing stress of 12,000 psi in the rivet shank, this slip had increased by 81 per cent to 0.00029 in. The increase for the same type of rivet combined with welding was similarly found to be 16 per cent. The unwelded high strength rivets showed an increase of only 8.6 per cent when subjected to repeated loading. The high strength rivet combined with welding slipped 23 per cent less after repeated loading than before, due undoubtedly to release of internal stresses resulting from the welding operation. The cold-driven specimens slipped 23 per cent less after repeated loading, due undoubtedly to the tendency for the prior repeated loading to "set" the shank of the rivet in the galleries which must have been present in these specimens. This must also have been true for the cold-driven rivets combined with welding where the slip of the specimens subjected to repeated loading was 38 per cent less than that for the specimens subjected to static load. The specimens which were welded only showed no effect from the repeated loading.

In view of the even more erratic behavior of the countersunk rivet, it is likely that the effect of repeated loading would be even more pronounced on this than the round head type. The important point to observe is that the hot-driven rivets are severely affected by even a few repetitions of load. This means that when such rivets are used in ladle hooks, the reapplication of load due to lifting the ladle will tend to loosen the plates or increase the amount they slip. The variation in temperature from the hot to the cold side of the ladle hook will of course produce the same effect as an actual load. This temperature strain in the plates will affect each riveted connection in the same manner as a load applied to the hook but will also produce combined bending and direct load as will be discussed later. The effect on the riveted connection will be the same as the repeated loading applied in these tests and will undoubtedly produce additional slip. When welding is combined with hot-driving, the stability of the connection when subjected to repeated loading is improved and it would seem desirable to combine the two methods if hot-driving is to be employed.

From the data obtained in these studies, it must be concluded that hot-driven rivets would be superior to cold-driven rivets for ladle hook construction. The difficulties attending the fabrication of such large plate assemblies with countersunk cold-driven rivets substantiate such an observation. Although most erratic in behavior, the initial grip of the long hot-driven rivet appears to be a desirable property in ladle hook construction. A possible advantage of the cold-driven rivet in high temperature work is its capacity for taking tension along its shank caused by heaving of the plate under the head. Under such conditions a hot-driven rivet might possibly be subject to enough additional tension so that the stress resulting from such loading and the initial grip would exceed the yield-point of the material.

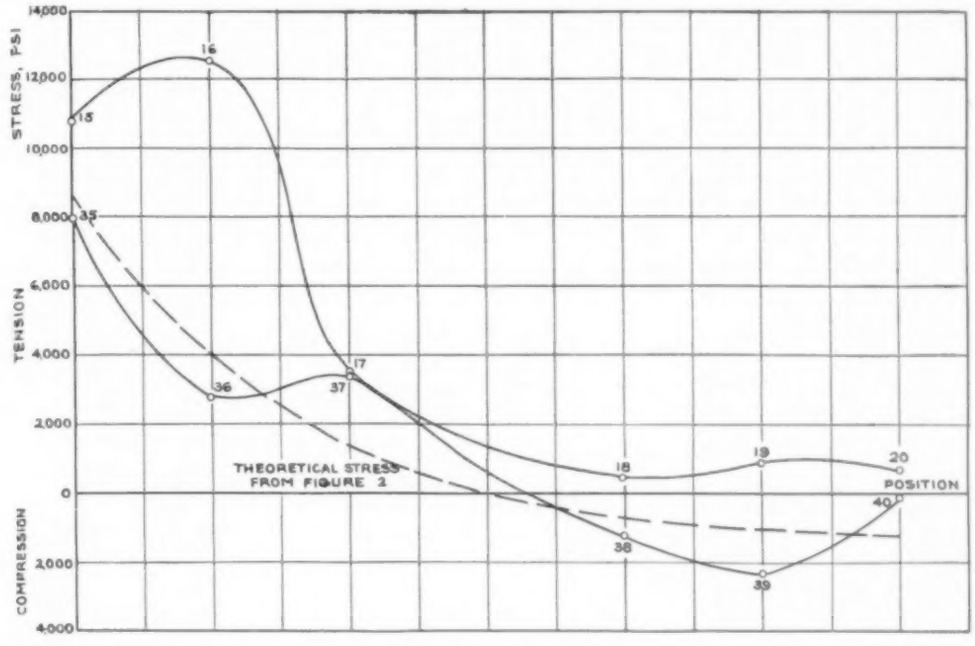


Figure 12 — The graph gives a comparison of observed and theoretical (uncorrected for transverse bending) stress for the hot and cold sides of the hook across the face of the bight.

It is recommended that any welding operation used be performed before the riveting operation. Ladle hook plates could be assembled with setting up bolts placed in holes which were undersized for the rivets. After the welding operation was completed, these holes could then be drilled to size for the rivets and the driving operation performed. This would minimize the presence of galleries in the rivet hole and would eliminate locked up stresses and possible injury to the plates of the hook if the operation were reversed.

Ultimate shearing stresses for the various rivet joints as given in Table I, show the higher shearing stress permissible for the alloy rivet material than for the standard type. This table also shows that the unit ultimate shearing strength of a joint which is both hot-driven and welded or cold-driven and welded is not as high as for the riveted joint alone. This is due to the

TABLE II

DETERMINATION OF ELASTIC SPRINGBACK

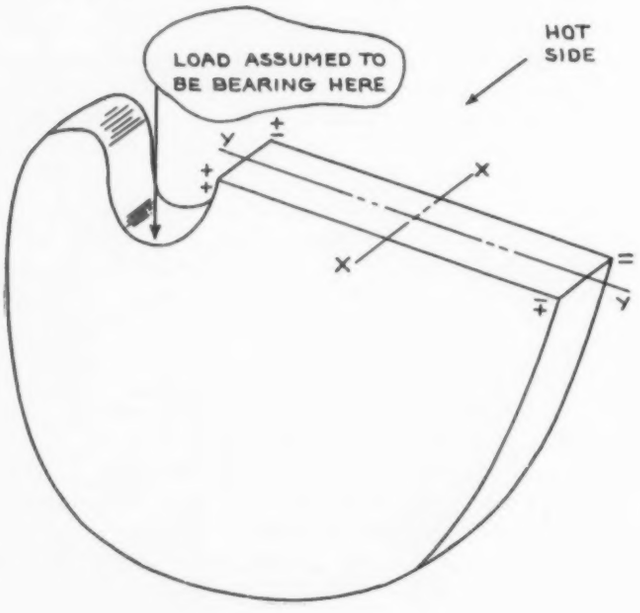
Specimen	Rivet material	Manner of driving	Original[1] length, in.	Final[2] length, in.	Springback, in.	Equivalent unit strain,[4] in. per in.	Equivalent unit stress, psi
43-a	A141-39	Hot driven	7.463	7.457	0.006		
43-b	A141-39	Hot driven	7.495	7,487	0.008		
43-c	A141-39	Hot driven	7.483	7.476	0.007		
Average					0.007	0.001036	31,050
44-a	A195-39	Hot driven	7.443	7.432	0.010		
44-b	A195-39	Hot driven	7.445	7.435	0.010		
44-c	A195-39	Hot driven	7.407	7.400	0.007		
Average					0.009	0.001332	40,000
45-a	A141-39	Cold driven	7.572	7.569	0.003		
45-b	A141-39	Cold driven	7.593	7.591	0.002		
45-c	A141-39	Cold driven	7.533	7.534	—0.001[3]		
Average					0.001	0.000148	4,440

Note: All measurements are the average of four individual points and were obtained with a dial indicator reading to 0.001 in.
[1]Before relaxing rivet
[2]After relaxing rivet
[3]Minus sign indicates an increase in length
[4]Based on a grip length of exactly 6.750 in.

fact that beyond the load for sudden slip for the hot-driven rivet or beyond the elastic range for the cold-driven rivet, the rivet shank and the welded material cannot work together. This means that the maximum shearing stress calculated by dividing the ultimate load by the total shearing area gives a lower apparent ultimate stress. No general significance is attached to this point, however, or to the ultimate strengths given in Table I, since the joints of a ladle hook will have failed by loosening of the plates long before the ultimate strength of the rivets has been reached. This concept of failure in service rather than failure by fracture is most important in a composite structure such as a ladle hook.

The results of the elastic springback tests are given in Table II. The alloy rivets were able to withstand a high unit stress without yielding and therefore exhibited more springback than did the A 141-39 rivets. The cold-driven rivets exhibited a springback of 0.001 in. in their total length, a negligible amount. Equivalent unit stresses for the springback strains are also given in Table II. This data shows that the average stress set up in the A 141-39 rivets was 31,050 psi, which is almost equal to the average yield point stress of 33,800 psi found for the rivet stock. The equivalent unit stress of 40,000 psi calculated for the A 195-39 rivets is considerably less than the yield point of 46,613 psi found for this material.

Figure 13 — Sketch illustrates the manner in which unsymetrical load is applied. The sign in each corner indicates whether the stress is tension or compression, the upper sign being for bending about the X–X axis and the lower sign for the Y–Y axis.



FIELD TEST OF WELDED HOOK

Observed temperatures in the welded hook are shown in Figure 9 for the three temperature gages used. It will be noted that the temperature in gage T 2, which was located 15 in. above the lip of the ladle, increased rapidly to 920 F. At this point the fiber shield, placed over the gage, ignited, setting fire to the insulation on the lead wires and causing them to short out. The temperature of 920 F shown in Figure 9 was the last observed temperature. The failure of the lead wires occurred less than a minute after this reading was taken. In an effort to more accurately determine the temperature at which this gage was shorted out, a sample of the fiber material was placed in an electric furnace and heated to the temperature where it ignited. This temperature was found to be 1035 F so the temperature in the neighborhood of gage T 2 must have been approximately equal to this value.

The observed stresses, uncorrected for temperature,

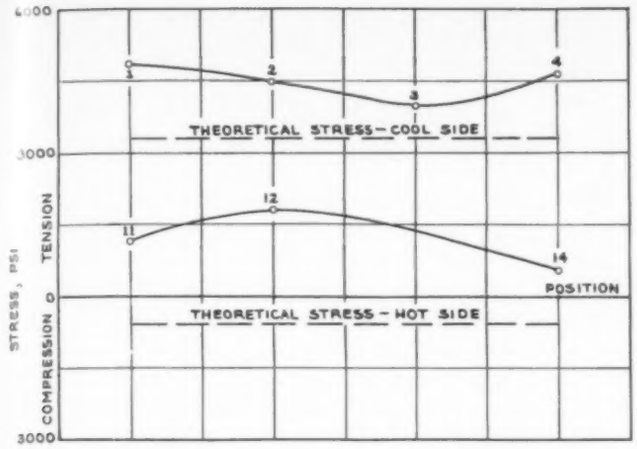
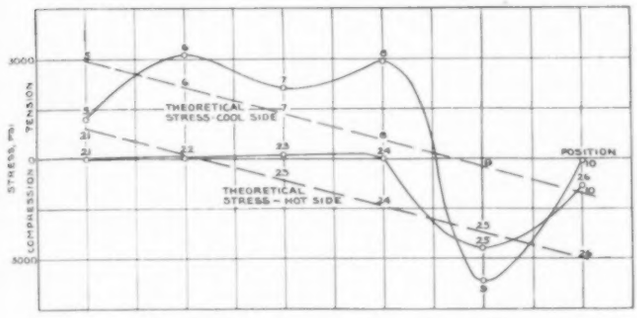


Figure 14 — Shank stresses compared with the theoretical stresses for the welded hook test after an allowance has been made for transverse bending.

Figure 15 — The graph gives comparison of theoretical and measured stresses for welded hook on the back edges of the hook after corrections have been made for transverse bending.



on the faces of the shank of the hook are shown in Figure 10. In Figure 11 the measured stresses are shown for gage lines placed along the back surface of the shank and the bight. Observed stresses across the bight of the hook are plotted in Figure 12. In these figures the theoretical stresses taken from the first part of this report are compared with observed values. The comparison indicates that the load was not uniformly distributed to all of the plates of the hook. At least the outside plates were not taking their proportionate share of the load as the difference between the two stress plots indicate. It will be noted from the figures that the hot side of the hook exhibited lower stresses than the cool side. This was due to the fact that the increase in temperature on the hot side of the hook caused it to increase in length and forced the entire hook into bending perpendicular to the plane of laminations. This forced the ladle trunnion to bear on the plates which are on the cool side of the hook. The hook therefore did not act as indicated in the previous theoretical analysis since the load was not symmetrically applied.

That the hook actually behaves in this manner can be proved by a theoretical analysis. Figure 13 shows the manner in which load will be assumed to be applied to the trunnion support. The assumption will be made that the load is applied at a point 1 in. from the face of the outside plate. This seems to be reasonable from an inspection of the welded hook since the trunnion support section on the cool side was found to be worn considerably more than the hot side. This could have occurred only if the hot side had increased in length as mentioned previously. Since the load of 102 tons was applied as shown in Figure 13 and the hook was assumed to be completely supported at the eye, the stresses due to this bending can be calculated from the ordinary flexure formula

$$s_e = \frac{Mc}{I}$$

in which

s_e = extreme fiber stress caused by eccentric load, psi

M = moment due to eccentricity of load, in. lb
= 204,000 x 2 = 408,000 in lb

c = one-half of width of section, in.

I = moment of inertia of cross-section in. ^{4}

For this hook the extreme fiber stresses will be

$$s_e = \frac{408{,}000 \times 3}{688} = 1780 \text{ psi}$$

This is the stress to be found in the extreme fiber of

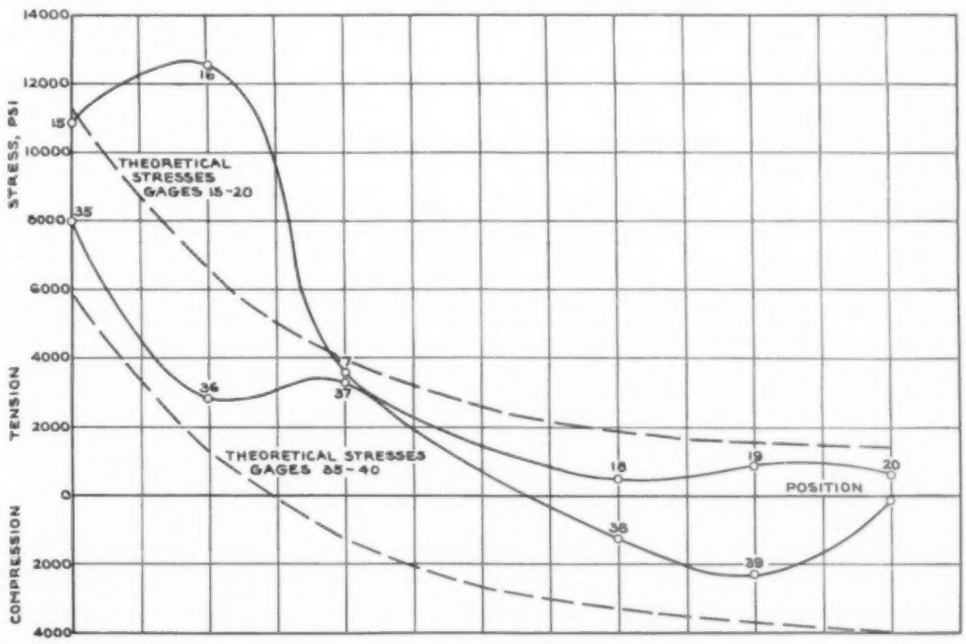


Figure 16 — Comparison of observed and theoretical stresses on the welded hook after corrections have been made for transverse bending.

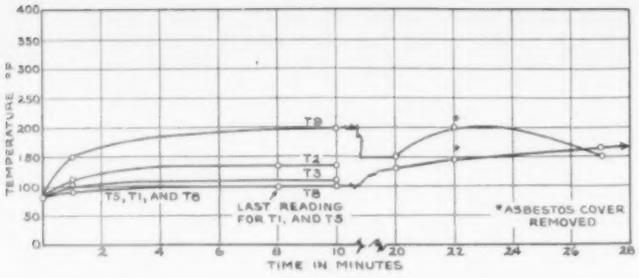


Figure 17 — The figure gives temperature-time curves for the tests on the unwelded hook.

the outside plates of the hook. The stresses will be compression for the hot side of the hook and tension for the cold side. In a similar manner the stresses may be calculated for those gage lines which were placed along the edge of the hook at the center of each plate. Since these points were in the plane of bending, the stresses varied from compression on the hot side to tension on the cold side. The magnitude of the stresses will be the same for comparable positions at the shank or at the bight. The stresses at these locations have been calculated to be as follows:

Center of first plate on the hot side:

$s_e = 1480$ psi, compression

Center of second plate on the hot side:

$s_e = 890$ psi, compression

Center of third plate from hot side:

$s_e = 300$ psi, compression

The stresses in the symmetrically opposite plates starting with the cold side are equal in magnitude to the above but are all tension.

Figure 13 indicates how the eccentric load effects the stresses at the bight, insofar as magnitude or tension or compression is concerned. When all of the various stresses at the shank or at the bight are added algebraically, the theoretical stress at any point can be determined. The fully corrected theoretical stress then consists of the following:

Theoretical direct stress

Theoretical bending stress about x-axis (Figure 13)

Theoretical bending stress about y-axis (Figure 13)

A comparison of observed values with the theoretical values thus obtained is made in Figures 14, 15, and 16. The comparison is considered to be better than was found in Figures 10, 11, and 12, in which observed stresses were compared with theoretical stresses based upon a symmetrical load.

Some of the difference between the observed stresses and the corrected theoretical stresses could be due to localized temperature effects or to the relief of localized stresses resulting from edge welding. The proximity of some of the gage lines to rivet holes plus the possibility of a combination of the other two sources of error may also be responsible for some of the error.

The comparison between observed stresses and the theoretical stresses based upon an unsymmetrical load lends support to the statement that the hot side of the hook increases in length due to temperature, throwing load onto the cold side. Apparently the heat in the portion of the hook which is above the lip of the ladle is sufficient to cause enough increase in length of the hot side to induce the eccentric loading observed. If only a length of 10 in. was exposed to the approximate temperature differential of 1000 F noted in these tests, the increase in length in this 10 in. would be 0.05 in. Obviously this is enough to force the hook into bending, throwing the load onto the cold side.

FIELD TEST OF UNWELDED HOOK

Observed temperatures for the gage locations shown in Figure 3 are plotted in relation to time in Figure 17. These curves show that the temperatures resulting from the killed heat were quite low by comparison with those observed for the unkilled heat lifted with the welded hook. The maximum temperature of 200 F observed for gage T 9 was found to be in good agreement with stresses determined from the dummy gages immediately below this gage point. It follows from the observed temperatures that a killed heat would have

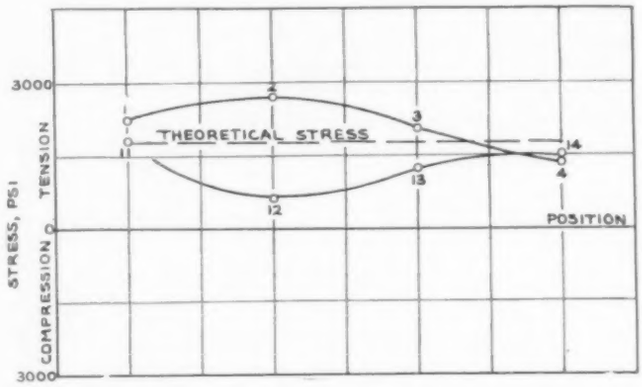


Figure 18 — Observed and theoretical stresses in shank of unwelded hook.

much less tendency to cause delamination of a ladle hook than would an unkilled heat. It is perhaps unfortunate that an unkilled heat could not be lifted with this unwelded hook since such a condition would have permitted a true comparison with the welded hook.

A comparison of theoretical and actual stresses in the shank is made in Figure 18 and for the back of the hook in Figure 19. The theoretical and observed stresses at the bight of the hook are compared in Figure 20. The theoretical stresses include direct stresses and those due to bending as calculated from the Winkler theory. From these figures it may be seen that the comparison is reasonably good, indicating that the unwelded hook was not being subjected to as great a temperature differential as was the welded hook. The difference between the theoretical stresses and the observed stresses is so small it can be concluded that this hook was being subjected to a symmetrical load. It does not necessarily follow that a new hook would tend to support load symmetrically by comparison with an old hook when subjected to high temperature on one face. Actually the new hook would be more likely to take the load on the outside plate on the cold side than would the old hook since the latter would be worn on the cold side as was discussed earlier. The temperature strain of 0.0006 in. per in. might have disappeared in part due to slip between the laminations. This would certainly have been true if the rivets were not tightly driven and therefore had little or no initial grip.

Because of the short service record of the unwelded hook (one day, as indicated previously) and the difficulty of comparing measured stresses resulting from the lifting of a killed and an unkilled heat, it is not possible to compare the welded and unwelded hook insofar as the superiority of one over the other is concerned. A reasonable conclusion to make, however, is that the hooks behaved in a manner which can be predicted by appropriate design procedures and that the stresses are within acceptable ranges.

A possible difficulty which might be encountered with an unwelded hook and which would arise out of the fact that the rivets might not be tight in the holes and have no initial grip, is the possibility that a psuedo repeated loading due to heating and cooling off the hooks might cause a breakdown of the riveted connections. This could be determined only by observing the unwelded hook over a service period of perhaps one year. It is felt that if a predominate number of unkilled heats are lifted with a hook, the heating and cooling effect will cause a repetition of bending action in the transverse direction that will cause a breakdown of the hook in as positive a manner as would an actual repeated load.

TESTS OF A HOOK PLATE WHICH FAILED IN SERVICE

During the course of this investigation it was possible to secure samples from the outside plate of a ladle hook which had been removed from service for repair because of the presence of cracks and other defects in this outside plate. Although exact service data for the hook could not be secured it is likely that this plate had been in use less than 8 years. At the time of inspection the plate had been removed from the ladle hook. Some areas of the surface were severely pitted due to exposure to hot metal and possibly to corrosion. The cracks had grown slowly during the last months of use, but an inspection of them showed that the portion of the cracks adjacent to the outside edge of the hook had been cracked for at least one year. These cracks resembled the usual fatigue failures at the portion which had cracked last. The other sections were in varying degrees of corrosion and the surface could not be examined satisfactorily. The missing heads of the countersunk rivets used in the hooks had broken from the shank sometime prior to the time of inspection since the fractured shank was severely corroded. The break was typical of a brittle material in tension indicating that the countersunk heads might have been injured metallurgically by heating and then hand hammering them into position.

Test specimens for both tension tests and photomicrographs were removed from the plate. The typical photomicrograph in Figure 21 shows no irregular surface condition and indicates that the steel of the plate was normal in every respect. Four such transverse specimens showed no decarburization. The microscopic examination therefore indicated no metallurgical breakdown of the plate material on the hot side of the hook due to the high temperatures to which it must have occasionally been exposed.

Five specimens were taken from each side of the hook and were found to have an average yield point of 45,500 psi, an average tensile strength of 71,600 psi and an average elongation in 2 in. of 25 per cent. There seems to be no evidence in these physical tests that would point to any deficiencies in the plate material which could explain the plate failures.

The actual failure of this hook was undoubtedly due to a combination of circumstances such as incomplete design, poor fabrication, a psuedo repeated load due to heating and cooling of the outside plate and other factors arising from the manner in which the hook was used in the mill. The data which is included in this report is given because it shows what might be expected if a ladle hook is allowed to remain in use until such failure occurs.

SOME SUGGESTED DESIGN DETAILS FOR LADLE HOOKS

Because of the reasonable comparison found between theoretical or corrected theoretical stresses and observed stresses in both the welded and the unwelded hooks, it appears as though the Winkler formula or similar formulas commonly used in practice are quite satisfactory. Any attempt to modify this relationship

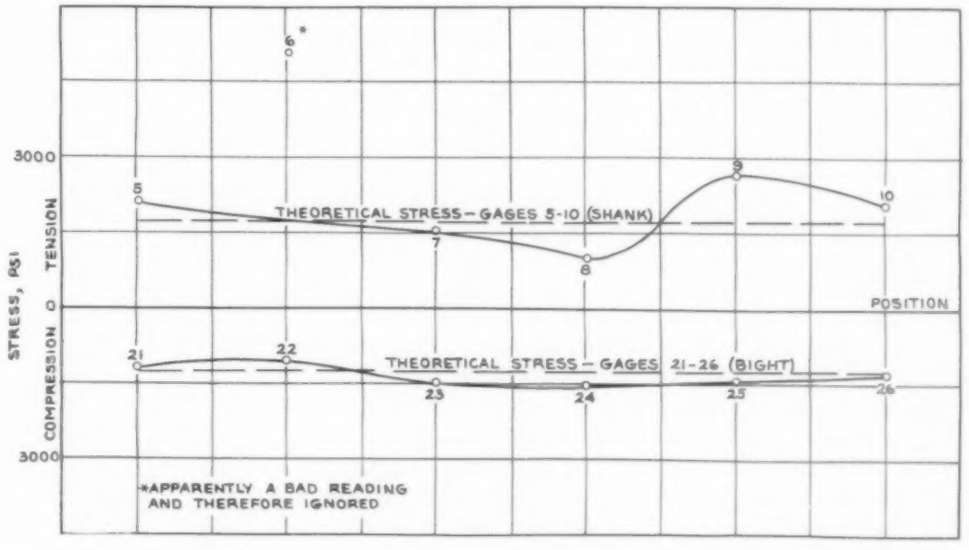


Figure 19 — Observed and theoretical stresses for back edge of shank and bight for unwelded hooks.

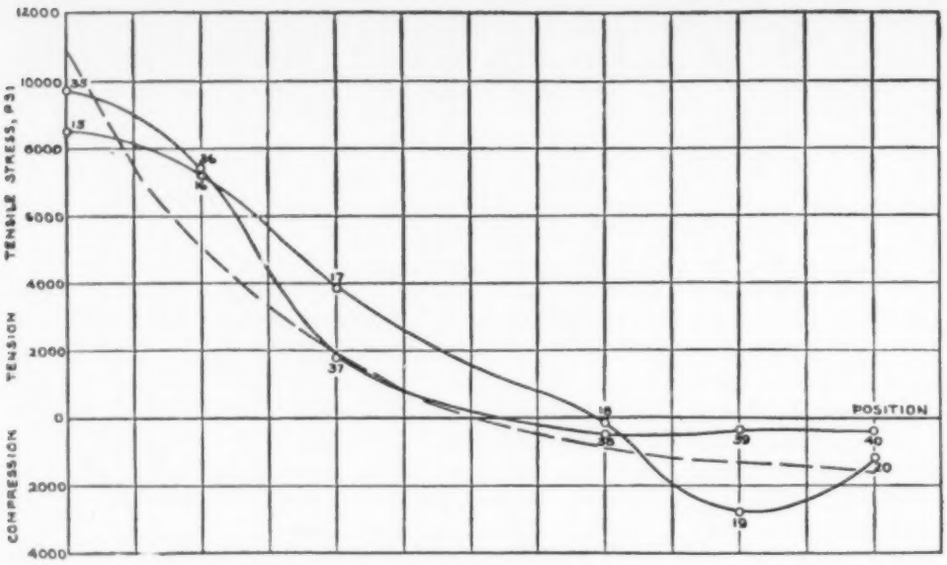


Figure 20 — Comparison of observed and theoretical stresses across bight of unwelded hook.

on the basis of the results obtained from the two field tests would not be reasonable. Additional field tests might uncover more evidence which would justify slight changes in design procedure, but it is quite likely that errors resulting from differences in driving of the rivets and fabrication of the hook would produce differences in stress greater than the slight error which might be reduced by the use of any modified design formula.

One change in design detail can be suggested, however, based upon the results of the field tests. Since the outside plates in the two hooks studied were of considerable thickness (¾ in. minimum) it can be expected that the action which temperature differential might have upon the hook would be quite large. This is due to the fact that a thick plate will have considerable cross-sectional area for a given width and the temperature strain will thus build up greater total loads than it would in a thin plate. Inasmuch as the outside plate on the hot side plays an important part in inducing transverse bending in the hook, it follows that it would be desirable to use a much thinner plate at this point. A further advantage of using a very thin outside plate is the fact that the coefficient of thermal conductivity for the gap between the plates is much less than that of the plate material itself. Machine Design (4) has presented some characteristic values for the coefficient of thermal conductivity as follows:

TABLE III

Nature of obstruction	Conductance range Btu/hr/sq. ft/°F
Metal wall — 1 in. thick	75 to 3000
Metal wall — 0.025 in. thick	3000 to 120,000
Condensing vapor	1000 to 4000
Gas being heated	5 to 50
Gas being cooled	5 to 40
Corrosion scale	5 to 20

From the above values it may be seen that the heat will be transmitted through the plate an average of 60 times faster than through the mill scale on the surface, or an average of 30 times faster than the air gap between the plates. The latter is a variable quantity since the plates are in contact at various points along their surface. The air gap is present in sections, however, and certainly will reduce the overall rate of transmissibility of heat. The insulating value of the first joint between the plates is apparent from this data.

A suggested design detail for a thin steel plate, to be referred to as an "insulating plate," is shown in Figure 22. Such a plate would provide the necessary insulation and yet not be heavy enough to take load. It will be noted from the figure that the insulating plate can be removed for inspection of the load carrying plates. The many scratches and cuts observed on the exposed faces of old ladle hooks indicates that this plate should be a minimum of ¼ in. thick. This thickness should be sufficient to withstand the ordinary scraping and bumping to which the hot side of the hook is subjected, and yet not so thin that it cannot be fabricated with the heavier load carrying plates without difficulty.

Since continued use of a hook in the lifting of unkilled heats might permit enough heat to penetrate the "insulating plate" resulting in transverse bending of the hook, it might be necessary to consider another improvement in hook design. This would be the employment of a spherically seated trunnion support which would automatically adjust itself to the rotation of the normal trunnion seat caused by transverse bending. No attempt will be made in this report to circumvent the design difficulties which such a suggestion arouses.

SUGGESTED DESIGN PROCEDURE

The studies covered by this report and the selected references make it possible to offer a recommended design procedure for ladle hooks. The following steps might be considered a check list for the designer:

1. Determine direct stresses by dividing hook load by net cross-sectional area of shank and of bight. The net cross-sectional area at each point is the gross area less the area of the rivet holes.
2. The maximum stress due to bending will be at the extreme inside fibers of the bight section. This stress can be calculated from the Dolan-Levine formula for curved beams as checked by Chang, Knudsen, and Johnston of Lehigh (3):

$$s_b = K_t\ (P/A + Mc/I)$$

in which

s_b = maximum stress on inside fibers of bight a distance c (in.) from the centroidal axis, psi
c = one-half section width, in.
P = applied load, lb
A = cross-sectional area, sq in.
M = bending moment at section, in. lb
I = moment of inertia of cross-section, in.^{4}

$$K_t = \frac{2-\alpha(R/c-1)}{3(R\alpha/c-2)\ (R/c-1)}$$

$$\alpha = \log_e\left(\frac{(R/c)+1}{(R/c)-1}\right)$$

R = distance from centroid of section to point of application of load, in.

Values of K_t for various R/c ratios are as follows (3):

R/c	K_t	R/c	K_t
1.2	2.89	1.8	1.63
1.3	2.39	1.9	1.57
1.4	2.10	2.0	1.52
1.5	1.92	2.1	1.48
1.6	1.79	2.2	1.45
1.7	1.70	2.3	1.42

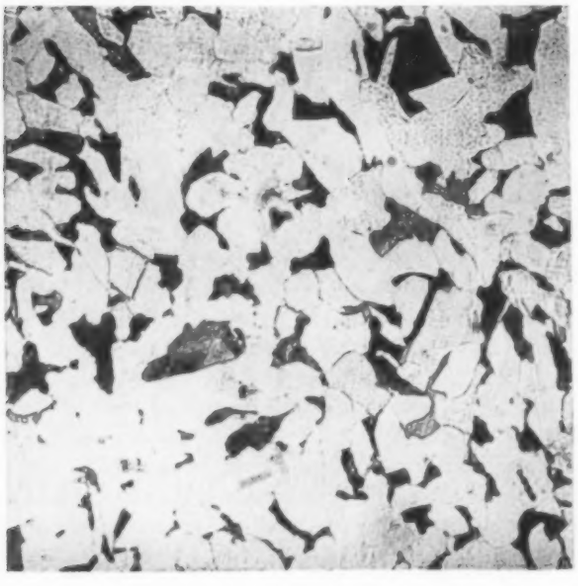
A simpler form for the extreme fiber stresses is given by Seely (5). In any case the stress distribution across the bight due to bending cannot be determined from a straight-line relationship.

3. If no insulating plate is employed as suggested below, allowance should be made for the eccentricity of loading due to the expansion of the hot side of the hook. A reasonable assumption to make is that the hook load will be applied at a point on the trunnion support one-sixth of the hook thickness from the hot side. These stresses can be calculated from the ordinary flexure formula

$$s = \frac{Mc}{I}$$

in which

Figure 21 — Photomicrograph (250 X) of surface of hook which failed in service.



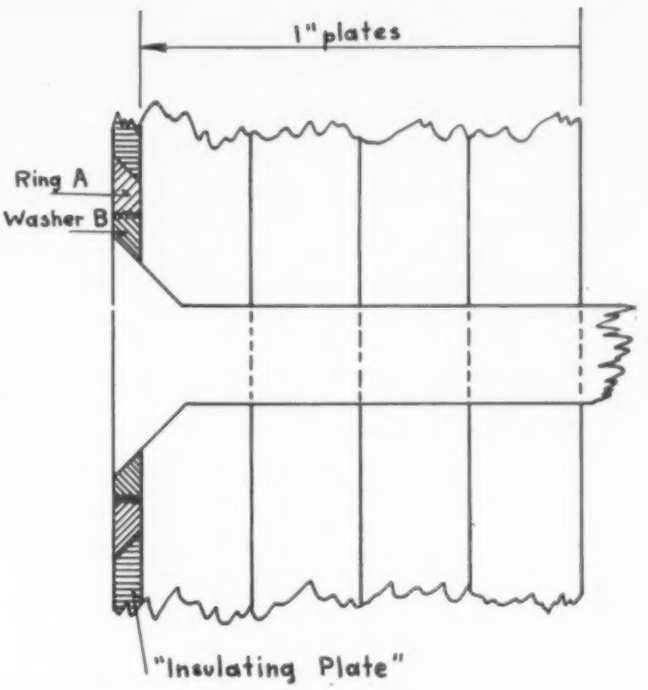


Figure 22 — The proposed hook design shown above proposes the use of an insulating plate to the hot side of the hook. Washer B is held in place by rivet and provides a threaded connection for ring A. Removal of ring A allows insulating plate to come free permitting inspection of the heavy plate. Whether such a design is practical or economical is questionable.

s = extreme fiber stress due to bending, psi
M = bending moment on section, in. lb = ⅓ (hook thickness) x hook load
c = one-half hook thickness, in.
I = least moment of inertia of shank or bight cross-section, in.^{4}

These stresses will be compression on the hot side of the hook and tension on the cold side.

4. Total maximum stresses at the extreme fibers of the bight or in the shank can be determined by algebraically adding the stresses calculated in steps 1, 2, and 3.
5. Hot-driven countersunk rivets should be driven so that the maximum initial grip can be obtained. This requires that the jaws of the rivets be left closed until the rivet has cooled to a black heat. Riveting should be combined with, but should follow edge welding. Rivet holes should be reamed to size after the welding operation.
6. The stresses due to transverse bending as determined in step 3 can be eliminated by using a ¼ in. thick insulating plate on the hot side of the hook. A suggested fastening detail is given in Figure 22.
7. Because the alternate heating and cooling of a ladle hook produces a psuedo repeated loading it is recommended that tensile or compressive unit stresses be limited to 18,000 psi and shearing unit stresses to 12,000 psi.

It is important to note that this design procedure is correct only for loads applied to the trunnion support and due to the lifting of a ladle. If loads are to be carried on the point of the hook, the designer should allow for this condition.

CONCLUSIONS

The data presented in this report substantiates the following conclusions:

1. Hot-riveting and edge welding should be combined in ladle hook fabrication to provide a connection that offers the greatest resistance to the effects of heating and cooling of the hook. Such riveting should be done after the welding operation has been completed and the rivet holes reamed to size.
2. Normal design procedures, such as the Winkler theory or data based on photoelastic tests, will satisfactorily predict the stresses which will be set up in a ladle hook.
3. Temperatures as high as 1000 F may be reached on the surface of the shank of a hook used to lift an unkilled heat. Metallographic and physical studies of specimens taken from an old hook that had been removed from service give no evidence that failure of surface plates can be attributed to the metallurgical effects of high temperatures.
4. High temperature on the hot side of a ladle hook will cause it to increase in length, throwing the trunnion load onto the cold side. This condition will cause transverse bending of the hook and resulting peak stresses greater than normal.
5. Reduction or elimination of temperature stresses may be effected by placing a thin (¼ in.) steel plate over the entire hook surface on the hot side.

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DISCUSSION

PRESENTED BY

LEONARD LARSON, Chief Engineer, Corrigan-McKinney Plant, Republic Steel Corp., Cleveland, Ohio

C. MUHLENBRUCH, Associate Professor of Civil Engineering, Northwestern Technological Institute, Evanston, Ill.

H. W. BALL, Assistant Chief Engineer, Morgan Engineering Co., Alliance, Ohio

T. F. REED, Engineering Department, Alliance Machine Co., Alliance, Ohio

J. A. EVANS, Asst. Chief Draftsman, Republic Steel Corp., Canton, Ohio

F. W. CRAMER, Electrical Engineer, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

BRUCE G. JOHNSTON, Research Director, Lehigh University, Bethlehem, Pa.

Leonard Larson: Professor Muhlenbruch has ably presented some interesting and constructive data pertaining to design and action of ladle hooks. It is my understanding that his paper, which has been briefed for presentation to this meeting, will be further studied by a sub-committee of the standardization committee in connection with program to develop better ladle hook design. A ladle hook carries considerable responsibility, and all of us who play any part in their design and application will profit from further analysis of his observations.

Member: I just wanted to say that from a design standpoint I would be interested in knowing why the rivets in the hooks should be all countersunk or would it not make a better job to have a full rounded rivet?

Now, the tests on the ladle hooks were made with countersunk rivets, but a great many ladle hooks are built with full heads because there is a trunnion bushing in the hook which is flanged and the flanges of these bushings are thick enough so that they extend out at least as far as the rivet heads. Therefore, there is no interference as far as hooking on the ladle is concerned. That is just a point that might make a little difference in the value of the rivets. I think the round head rivet would be better than the countersunk rivet.

Professor Muhlenbruch: The paper points out that the round head is superior to the countersunk head. The round head rivets were used for the tests because countless other investigators have found that the countersunk head varies considerably in load-slip relationship. I think it is up to the Standardization Committee to determine the type of head that should be used. Personally, I would prefer a round head. The initial slip loads which I observed cannot be obtained with countersunk heads.

H. W. Ball: I would like to ask which is better, cold or hot-driven rivets?

Professor Muhlenbruch: The paper recommends, on the basis of the data observed, that the hot-driven rivet is the best because it produces the greatest initial grip which, in combination with welding, gives adequate strength for ladle hooks.

My objection to using hot-driven rivets alone for such applications is that the pseudo loading due to temperature differential might duplicate the 18 per cent increased slip observed after three hundred repetitions of a load equivalent to 12,000 psi shearing stress in the rivet shank. Therefore, I recommend in the paper that hot-driven rivets be combined with edge welding. The cold-driven rivets tested in this investigation do not compare with this combination. In comparison with the ordinary structural rivet, there is no advantage in using the high-strength rivet. This is particularly true when the rivet is combined with edge welding.

T. F. Reed: There is one question I would like to have answered. Is there any research being done on the selection of the laminations; that is, how thick each plate should be? Would you recommend thin plates on inside and thicker plates on the outside of the hook?

Professor Muhlenbruch: Following the recommendation of the paper, the quarter-inch "insulating" plate can be used or in any case a comparatively thin plate should be used on the outside.

Member: How many years service should we give a ladle hook without replacing it? I have had occasion to have plate breaking in ladle hooks which I have replaced. I then felt that I did not do right and that I should have replaced them with new hooks. I was just wondering whether anybody could tell me how many years we should use a ladle hook before throwing it away.

J. A. Evans: We have had a lot to do with ladle hooks in the last 20 years and have had failures at one plant and none at another, and after comparing the designs used we decided that the outside plates should be heavier because the plant that had no trouble was the one that had the heavy outside plates.

Now, the reason behind this is that the load is rarely on a line bearing across the width of the hook, it is usually on the outer edge, and the outside plate takes the load because the rivets do not make the plates work together. The way we cured it was by redesigning our hooks so that the outside plates are heavy. The solid hook, of course, is far superior to laminated hooks. Making the outside plates heavy is only a step toward the solid hook.

Professor Muhlenbruch: If the plates of the hook can be made to work together perfection has been achieved and the fasteners and plates are working properly. The use of a thick outside plate assumes that this plate takes the stresses of transverse bending loads (due to temperature) and that the other plates are in effect not working. Now, therein lies a quandry, and it is up to the designer to decide whether the fastening fabrication technique is such that he can assume all the plates work together or whether he just assumes that these outside plates take the load. Because of the many variables involved I would find it difficult to discuss this point except for specific cases.

I am interested in this particular comment because, during the course of this investigation, I made it my business to ask a number of operating people if they had any type of trouble with ladle hooks. Some replied that they never had trouble. Others stated that they have trouble and were duly concerned by the problem. I did not converse with everyone, so I do not know the answer, but it does tie in with a previous question, how long do ladle hooks last? I do know that I saw some very complete failures.

J. A. Evans: I would like to know, also, when you are supposed to scrap a hook. That is a problem that has been worrying me quite a lot. Again, in regard to which edge of the hook the load comes on, there is no way of knowing that, because we have a lot of ladles and not too many hooks, and they all wear differently. The load may be on either of the outside plates. While jumping molds the hooks rock on the trunnions.

However, in two plants, as I said before, the one had no trouble, and the other did have trouble, so it bothered us because we had so many failures in the other plant. We discovered the reason. The plant that had no failures had heavy outside plates. If you follow that same reasoning throughout, you will find that the solid hook is far superior because you have no fastening trouble. In part of one plant where we use smaller and thinner hooks, we have used solid hooks for 7 years.

The transverse strength of a laminated hook is very small compared to a solid hook because the fastenings do not hold.

Prof. Bruce Johnston: It seems to me that one way to throw some light on this very important question would be to continue the investigation still further and make fatigue tests, going to several million loadings, combined with heat cycles. Then one would have a quantitative approach to the question. Actual operating conditions would vary but at least a partial answer would be obtained.

F. W. Cramer: When the ladle hook committee started to plan this project, one of the first moves was to collect design drawings of the many different hooks in use. A few of these designs were of solid hooks that were used on 50 to 75-ton cranes.

Possibilities for using solid hooks were discussed, particularly what type of test or inspection could be given the steel to make certain flaws did not exist. There was not too much criticism of the idea, but in the real test, none of the committee members would offer to adopt such a design.

On the large ladle cranes—250 to 300 tons—the hook may be 20 ft long and 10 in. thick. If this were cut from a single slab, its weight would be about 17 tons. Straightening, cutting, machining and heat treating a slab this size would present difficulties to the manufacturer.

The committee does not condemn the use of solid hooks and would welcome data from any users, but feels that with the laminated hooks we can be more certain of an assembled item that will have the safety factors called for in the design.

Prof. Bruce Johnston: Would not the multiple plate hook give you more warning of failure than a solid hook?

F. W. Cramer: On the modern laminated hooks—maybe I am talking out of turn, but I do not think we have a lot of this trouble we used to have on this famous rivet-popping business. The reason for that is that they have been studying where the stresses are and the rivets are placed differently. In addition, we are doing this welding that Professor Muhlenbruch talked about. On that type of hook I have not heard of any rivets popping. There may be cases but I have not heard of any. Does anyone know of any?

Member: That is a pretty hard question to answer, but I do not think they pop them by lifting, I think they do other things with the hook.

We have broken rivets on occasion where the heads break off and we have never been able to tie down just what the cause was, whether it was due to rough usage or whether due to failure of the rivets due to loading. I believe it is due to rough usage.

AISE STANDARD NO. 7

SPECIFICATIONS FOR DESIGN OF LADLE HOOKS

(OCTOBER 2, 1949)

I. SCOPE

A. This specification will cover laminated hooks, rectangular in cross-section, used for lifting hot metal ladles. If the purchaser should specify a solid ladle hook, the following design procedure is generally applicable.

II. MATERIALS

A. Hooks shall be made of flange quality rolled steel plate conforming to ASTM specifications A-285 for grade B basic steel.

B. Rivets shall be made of ASTM A-31 boiler rivet steel, Grade A.

C. Supporting bushings shall be made of steel conforming to ASTM specification A-235, class F, or of steel conforming to SAE 1040.

D. If a solid hook is specified, slab from which hook is cut must be free of flaws and defects as determined by X-ray or supersonic inspection methods.

III. FABRICATION

A. The thickness of the laminated plates shall be not less than ½ in. The individual plates in each hook shall be machine flame cut to size. The surfaces where the wearing plates are to be installed will be machined after the hook is assembled.

B. Unless otherwise specified, the plates shall be held together by hot-driven rivets, which have been heated through their entire length. Wherever clearance permits, buttonhead rivets will be used. If clearance is insufficient, countersunk rivets may be used. Holes for rivets shall be drilled and reamed to size after plates have been assembled.

C. No rivets shall be closer than ⅓ of the width of the plate (or 6 in. when width exceeds 18 in.) to the inside surface of the wearing plate at the point of maximum stress as shown in the sketch.

D. The edge distance for rivets other than those at the critical section in the bight shall be not less than 2½ in. from the center of the rivet hole to the edge of the hook.

E. In the eye section of the hook, no rivets will be located above a line which is located at a distance of 1½ times the diameter of the supporting pin below the center line of the supporting pin.

F. The portion of the plates above this line are to be welded together. The plates may be intermittently welded along the shank edges if specified by the purchaser.

G. Riveting work on hook shall be completed before hooks are edge welded.

H. The net section of the hook at the eye (in the horizontal plane) shall be at least equal to that at the shank, and shall also have sufficient area so that the maximum stress at this section does not exceed that established by Clause VI, D. The thickness of this section will gradually be increased to a maximum through the vertical plane through the center of the hole for the eye pin. At this point, the section will have a minimum thickness which is equal to that through the horizontal plane plus one-fourth the diameter of the hole.

I. To allow for clearance, the thickness of the hook shall be 1½ in. less than the length of the trunnion between the flange and shoulder.

IV. WEARING PLATES

A. The inner surface of the hook that comes in contact with the ladle trunnion and the outside of the tip of hook shall be protected by a steel wearing plate not less than ¾ in. thick. The trunnion seat wearing plate shall contain not less than 0.25 per cent carbon, will be machined to fit the laminations, and will be held in place by welds. Under the wear and pumping plates the plate edges shall be scarfed and joined together with a continuous weld.

B. If specified by the purchaser, the wearing plate may be omitted; in which case a layer of hard surface weld will be applied to the inside of the hook, and ground smooth.

V. SUPPORTING BUSHING

A. The eye end of laminated hooks shall be provided with steel bushing. A press fit will be used to insert the bushing in the end of the hook and in addition it will be doweled or welded as specified by the purchaser.

B. The minimum bushing thickness will be not less than one-eighth the pin diameter or less than ½ in. for undowelled bushings, or 1 in. for dowelled bushings, whichever thickness is the greater.

VI. COMPUTATION OF DESIGN STRESSES

A. Hooks shall be designed for the sum of the stresses due to the following loads: (1) direct load, (2) bending in the plane of the hook, and (3) lateral or sidewise bending.

1. The stress due to the direct load shall be determined by dividing the rated load on the hook by the net cross-sectional area of section considered. The net cross-sectional area at each section is the gross area minus the area of the rivet holes.

$$S_d = \frac{P}{A}$$

P = Vertical load on hook

A = Net cross-sectional area at section being considered.

2. The maximum stress due to bending in the plane of the hook will occur at the inside

fiber of the bight section. It will be computed from the modified Winkler theory for curved beams as follows:

$$S_b = \frac{K_t M c}{I}$$

where M = applied bending moment about centroidal axis.

c = distance from centroidal axis to extreme fiber of the surface of the beam at the inside of the hook.

I = static moment of inertia of the cross-sectional area about the short centroidal axis.

$$K_t = \frac{2 - \alpha(R/c - 1)}{3\,(R\alpha/c - 2)\,(R/c - 1)}$$

where $\alpha = \log_e \frac{(R/c+1)}{(R/c-1)}$

R = distance of centroidal axis of section to line of application of load.

Values of K_t for a rectangular section are given in the following table:

TABLE I

$\frac{R}{c}$	K_t	$\frac{R}{c}$	K_t
1.2	2.89	1.8	1.63
1.3	2.39	1.9	1.57
1.4	2.10	2.0	1.52
1.5	1.92	2.1	1.48
1.6	1.79	2.2	1.45
1.7	1.70	2.3	1.42

3. The maximum stress due to lateral bending will be computed from the simple beam formula, with the rated load applied one in. in from the outside edge of the hook:

$$S = \frac{P(t/2 - 1)\ t/2}{I_{lateral}}$$

where t = thickness of hook and

$I_{lateral}$ = the lateral moment of inertia of the cross-sectional area about the long centroidal axis.

B. The stresses in the bight will be the sum of the three stresses enumerated above or:

$$S = \frac{P}{A} + K_t \frac{Mc}{I} + \frac{P(t/2 - 1)\ t/2}{I_{lateral}}$$

and the sum of these stresses shall not exceed 12,000 psi.

C. The shanks shall be designed for the sum of the following two stresses:

$$S = \frac{P}{A} + \frac{P(t/2 - 1)\ t/2}{I_{lateral}}$$

and the sum of these two stresses shall not exceed 12,000 psi. Areas, moments of inertia and other applicable values will correspond to the section for which the stress is being computed.

D. The stress at the section through the eye shall be computed as follows:

$$S = \frac{3P}{A} + \frac{P(t/2 - 1)\ t/2}{I_{lateral}}$$

and the sum of these two stresses shall not exceed 12,000 psi. Factor of 3 on vertical load in equation has been included to take in account stress concentration.

E. If stresses in designing are so high as to result in a deep slender hook, designer should contact purchaser on possibility of using longer trunnions on ladles to permit use of a thicker hook.

VII. RIVET DESIGN

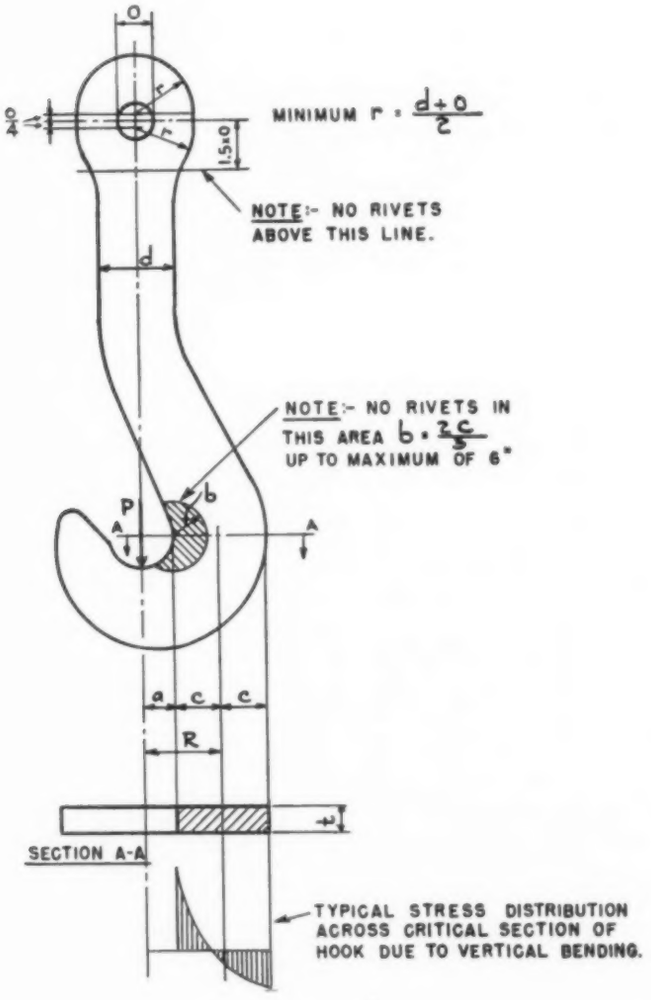
A. The total cross-sectional area of the rivets shall be sufficient to take the full rated load on the hook in shear. Shear stress is not to exceed 12,000 psi.

$$A = \frac{P}{12{,}000}$$

where A = total cross-sectional area of all rivets

P = vertical load on hook.

Nomenclature for stress formulae and limiting dimensions for ladle hooks.



EARTH LEAKAGE PROTECTION

for Underground Systems

. . . . the designer of transmission lines for steel plants should think of fault currents in terms of amperes only rather than in terms of hundreds of amperes . . . .

By K. S. KUKA

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▲ PROBLEMS of power supply in a large integrated industrial concern such as steel plants, are specific in the sense that a large amount of power is concentrated in a comparatively limited area, where continuity of power supply is of great importance for the various correlated processes of manufacture.

To obtain continuity of power supply, the most suitable power distribution would be a ring main system operating in a number of closed rings so laid out that even if the largest feeder on a substation bus trips off, the power available at the bus is sufficient to carry the maximum sustained peak loads without overloading any of the remaining feeders.

The investment in such a system will naturally be high, both in the installed plant capacity as well as in the discriminating protective system necessary. The most convenient protective method for such a system would be the pilot wire relaying which will be highly discriminating as well as quick acting.

However, there will be few plants, generating their own power requirements, which have such a complete ring-main system operating continuously in closed rings. Most of the plants have developed and expanded over a long period of years, with the result that the new power generating capacity and the distribution layout have to be correlated to the already existing system.

Figure 1 shows diagrammatically with approximate actual physical layout, the high tension distribution system of a large integrated steel plant, where the power supply system had to be expanded to suit the local conditions. Power House No. 3 as indicated is a new base load station, whereas Power House No. 1 and Power House No. 2, both old generating stations, have become major substations of the areas concerned. Power House No. 2 normally has a turbo-alternator set always on the line to take care of the excess steam, generated by the blast furnace gases for fuel economy. In order to keep the rupturing capacity of the circuit breakers to the minimum and to reduce the short circuit shocks on the system, the bus-couplers at the substation buses are kept normally open. The complete continuity of power supply has therefore to be sacrificed, and short shut-downs accepted until power is restored in the event a major feeder of a substation bus trips off.

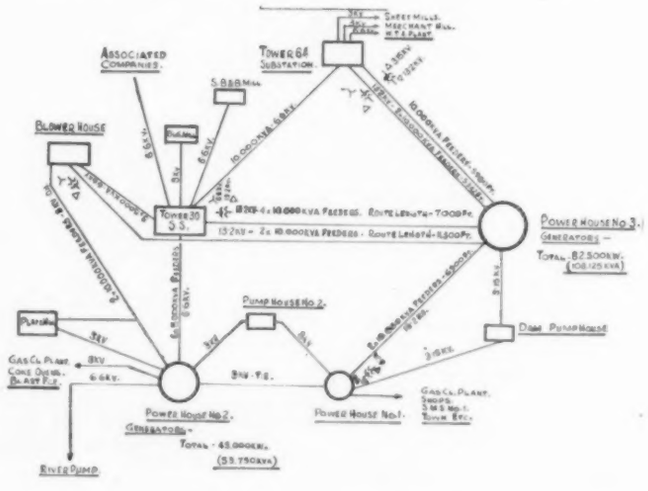
Even with underground feeders, the majority of the feeder faults are single phase earth faults, originating in cable end boxes and in insulation breakdowns to the lead-sheath of the cables. Though transient earth faults in cables are rare, it has been the author's experience that such faults do occur in cable joint boxes in certain conditions with insulated neutral system.

The system of protection normally provided is to ground one of the power house generators neutral over a resistance, and trip off the faulty feeder at once when an earth fault develops. To give the maximum generator winding protection, the value of neutral earthing resistance is normally selected to give full load fault current in case of a system ground fault nearest the generator terminals.

From the point of view of continuity of power supply, it would be desirable to find out means by which a feeder on earth fault can be left in service for a short time, while the suitable changeover is made on the system to remove the faulty feeder from service.

It is the object of this paper to propose a system of compensated ground leakage protection of the generators and the feeders combined, wherein the earth fault currents are reduced to a minimum harmless value, so

Figure 1 — A layout of the electrical transmission system for an integrated steel plant is shown in this diagram.



that the faulty feeder can be maintained in service for the short time required to make necessary changeovers.

The proposed sytem has the following main features:

1. It is a compensated ground fault system of protection, where the ground fault capacitive currents are neutralized by the reactive current, by using what is called a quenching transformer reactance grounding.
2. The main generators are arranged to be tripped off, if they develop an internal winding ground fault. It is not advisable to allow a generator to operate on a sustained body fault because of the danger of a second simultaneous earth fault elsewhere in the system, which would create a so-called double-earth fault, causing a phase to phase short circuit over the generator fault spot, which may cause heavy damage to the generator. About 90 per cent of the winding is safely protected.
3. As the cable network is limited, the "watt component" of the earth fault currents after compensation is very small, about 3 to 5 per cent of the total capacitive fault current. Such small currents therefore will take a long time to cause tracking in the cable insulation and create phase to phase short circuit. The faulty cable can therefore be safely kept in service for the period required to make the necessary system connection changes to remove the faulty feeder from service.
4. In case of a ground fault anywhere, the system gives indication of the particular section affected and the phase in which the fault lies.
5. The machines are relieved of the earth fault currents in case of system earth faults, because the quenching transformer absorbs all the fault current.
6. The insulation gradient of the system against earth has to be the same as between phases, the same as in case of an unearthed system.

CHARGING CURRENT IN INSULATED NEUTRAL SYSTEM

When an insulated neutral three phase system develops an earth fault, the faulty phase is brought at once to earth's potential, whereas the two healthy phases rise to line potential against ground, while the neutral of the system takes up a potential against ground equal to the phase voltage.

Figure 2 shows vectorially the condition of voltages and charging currents to earth when one of the phases goes to earth. From Figure 2 (b) it is seen that when phase R is grounded, its voltage against ground becomes zero, while the phases S and T take up the voltages R′S′ and R′T′ equal to the line voltage. The total capacitive earth fault current I_c is the resultant of the charging currents of the healthy phases, i.e., I_s and I_t, which is equal to three times normal phase charging current to ground. The phenomenon can better be understood if it is supposed that due to the grounding of one phase, a voltage appears between the neutral and the ground. This voltage tends to drive the currents through the circuit formed by the conductors, the fault spot and the capacities to ground of each phase. The

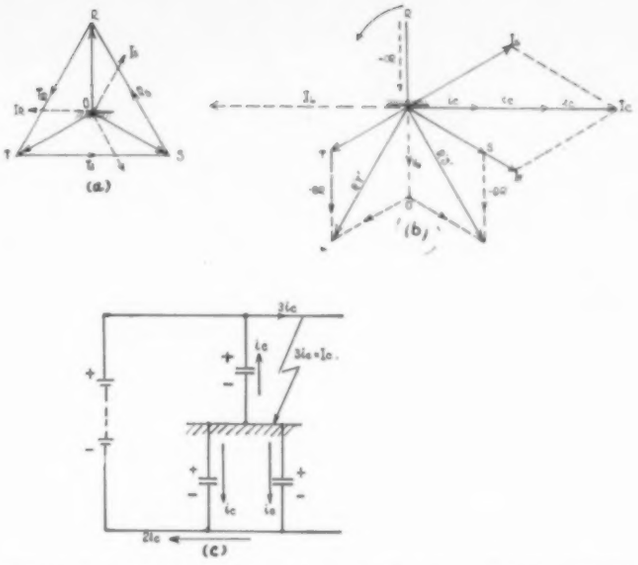


Figure 2 — (Upper left) a. Vector diagram shows voltage potential and charging currents in an ungrounded system. (Upper right) b. Condition of voltages and current when phase 'R' is grounded. (Bottom) c. Schematic diagram of flow of instantaneous charging current when phase 'R' is grounded.

grounded phase takes a reversed voltage to ground while the healthy phases rise up to the line voltage to ground. The phenomenon of the instantaneous charging and discharging of the earth capacities is schematically explained in Figure 3 (c). The voltage appearing between the neutral and the ground (V_o) tending to drive the currents through the circuit is shown as a battery, the instantaneous polarities being as indicated.

COMPENSATION OF EARTH FAULT CURRENTS

In Figure 2 (b) it is seen that earth fault current I_c leads the earth fault voltage V_o by about 90 degrees as the current is wholly capacitive. If therefore it is possible to pass during the earth fault condition, a reactive current I_L equal in magnitude to the capacitive current I_c and lagging V_o by 90 degrees, the resultant current at the fault may be brought down to almost a negligible value, i.e., the earth fault current is almost compensated.

The lagging reactive compensating current is generated by a so-called quenching transformer, a modified form of an earthing transformer with the well-known Peterson coil. The quenching transformer is a star-delta specially designed transformer, having open delta secondary with a variable specially designed reactance coil connected between the open delta terminals.

When a system phase develops an earth fault, a voltage appears between the open delta secondary terminals of the quenching transformer. Figure 3 shows the relationship between the various voltages under the fault conditions. Figure 3 (d) shows that the voltage appearing across the open delta secondary is equivalent to three times the phase voltage. This voltage when applied to the reactance coil, circulates a current which is reactive, i.e., lagging 90 degrees behind the

voltage V_o. This current, transformed to the primary, flows over the fault spot in the circuit and counterbalances the capacitive current.

Figure 4 gives a schematic representation of how the capacitive fault currents I_c and the compensating reactive current I_L flow in the circuit when the phase R of an outgoing feeder develops a dead earth fault. It should be noted that the resultant wattless currents through the alternator are counter-balanced, so that the machine is relieved of the wattless fault currents. Actually no currents flow through the faulty phase, while the wattless currents flow in closed rings over the healthy phases, through the neutral of the quenching transformer to ground, and thence over the ground capacitances of the healthy phases back to the lines and returning to the neutral; the loop is formed by the reactance and capacitance in a closed series circuit. The fault spot is thus totally relieved of the wattless heavy fault current.

Due, however, to the inherent heat losses, both in the quenching transformer windings and the cable capacitances to earth, there is always a small watt component of the circulating fault currents, which flows over the fault spot. Figure 5 shows the vector relationship of the actual currents and voltages. The wattless currents n I_c and I_L are each composed of the pure capacitive and reactive components, n I'_c and I'_L, and resistance watt components I_{RC} and I_{RL}, respectively. The phase difference between them and the neutral fault voltage V_o is therefore less than 90 degrees. The resultant current I_R represents the watt component, called the "rest current," which always flows over the earth fault, leaving a slight phase difference with the voltage V_o, depending on the tuning conditions of the circuit at the time.

Figure 6 shows schematically how the watt components I_{RL} and I_{RC} flow in the system in case of a feeder earth fault. It will be observed that the total fault current I_R flows over the fault.

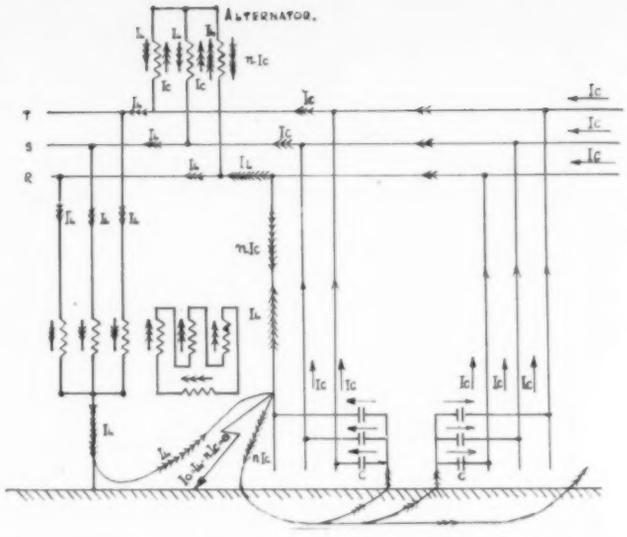
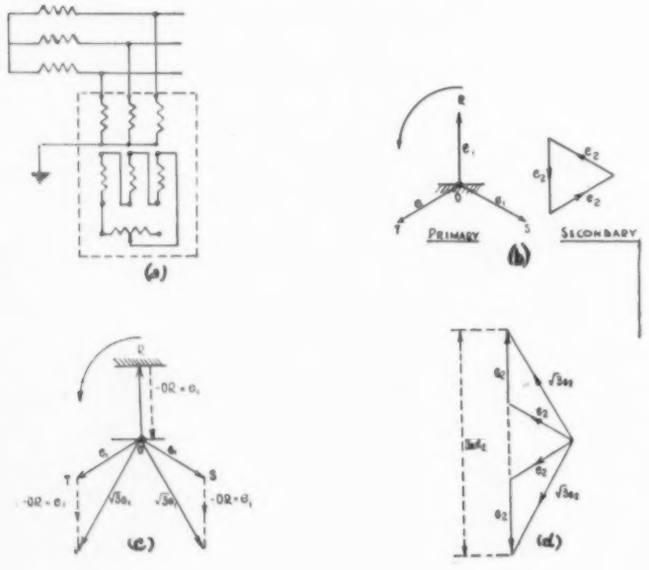


Figure 4 — Flow of capacitive ground fault currents nIc and compensative reactive currents IL through the circuit when one phase of a feeder is grounded.

Figure 3 — (Upper left) a. Schematic diagram showing a quenching transformer. (Upper right) b. Voltage relationship of quenching transformer when the system is not grounded. (Bottom left) c. Voltages across the primary of quenching transformer when phase 'R' is grounded. (Bottom right) d. Voltages across the open circuit terminals of the secondary of the quenching transformer when phase 'R' is grounded.



DISCRIMINATING GROUND FAULT RELAYING

Referring to Figure 6, it is noted that if relaying current transformers are connected in summation circuit to sift out the fault current, the direction of current in the relay coil in the faulty feeder is opposite to that in the healthy feeders. In the machines the currents are so directed that the resultant summation current is almost zero.

If, therefore, a wattmetric relay is connected so that its current coil is in the current transformers summation circuit, and its voltage coil connected to the secondary of the quenching transformer, the relay can be made to operate only in the faulty feeder, because only in that case will it develop a torque in the right direction to close its contacts. A completely discriminating earth fault protection is thus obtained.

EARTH FAULT RELAYING WITH LOW CAPACITANCE

After the earth fault current is compensated, the watt component of the rest currents, in case of underground cables, is only about 3 to 5 per cent. For a distribution system of an industrial plant, the watt component of the fault current will be very small. For the actual system, as per Figure 1, where the total capacitive current is about 80 amperes, the watt component of the rest current will be about 3 amperes.

In order, therefore, to relay such a system positively, it is necessary to superimpose a small additional current in phase with the rest current I_R. This is obtained by loading the secondary of the quenching transformer in case of an earth fault over a fixed ohmic resistance called the loading resistance. This introduces an artificial additional watt current which flows over the

earth fault and also through the current coil of the earth fault relay of the faulty feeder.

In Figure 7 the actual flow of the fault current due to the loading resistance is shown in case of the generator earth fault in phase R. The distribution of currents through the various phases and through the relaying transformer and the relays are calculated for 100 amp loading current on the quenching transformer secondary. The current flowing through the current coil of the earth relay of the faulty machine is about 0.11 amp and is in the direction for the relay to produce a torque to close its contacts.

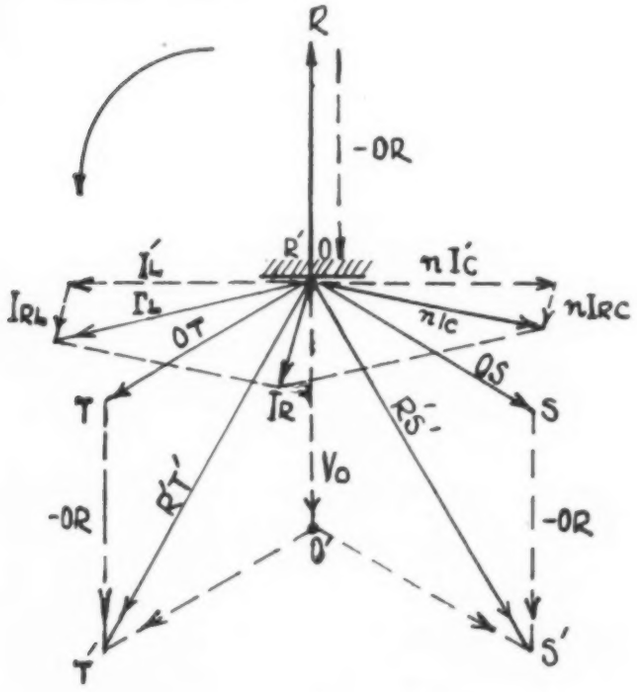
PROPOSED EARTH FAULT PROTECTION SCHEME

Figure 8 gives a single line diagram of a complete scheme of earth fault protection for generators and the feeders combined, in a system where power is transmitted directly at generated voltage. The diagram is drawn for one generator and two feeders. The scheme however, will operate selectively for any number of generators and feeders.

Quenching transformers (2)—The quenching transformer is provided with two secondary windings, one open delta connected and the other star connected. Variable reactor (3) is connected across the open delta terminals. Tapping of the reactor is selected to tune the circuit with the total number of feeders in service at the time so that the compensation of capacitive currents is as complete as possible.

As soon as an earth fault develops anywhere on the system, a voltage appears at the open delta secondary terminals, which generates reactive current in the reactor, depending on the tap selected. This current therefore compensates the capacitive fault current and

Figure 5 — Vector diagram of voltages and currents with phase 'B' grounded.



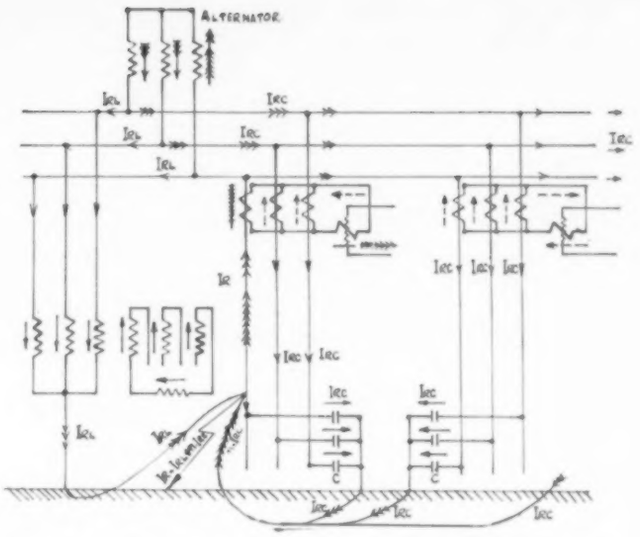


Figure 6 — Flow of watt components of ground fault currents IRC due to compensating reactance and IRC due to capacitance when one phase of a feeder is grounded.

reduces the effective fault current at the fault to a small rest current as already explained.

Auxiliary transformer (4)—This transformer is provided to step down the earth fault voltage appearing on the secondary open delta terminals of the quenching transformer for measurement and relaying. It gives the equivalent of the voltage V_o in the vector diagrams in Figure 5.

Earth Fault supervising relay combination (6)—The relay combination contains three independent highly sensitive directional relays of wattmetric type. The relay selects the faulty phase and prepares the system further for relaying purposes. The relay has two coils. One coil of each relay is connected to phase to phase voltage taken from the auxiliary secondary windings (2B) of the quenching transformer, while the other coil of each relay is connected in series across the secondary of the auxiliary voltage transformer (4). The relay is designed to give its maximum torque in the contact closing direction when the voltages impressed on the two coils have 90 degrees phase difference.

Vector diagram in Figure 8A indicates the selective operation of only one of the three selective relays. The relay which has a reference voltage Vector $\overline{S-T}$ impressed on its coil, will have its positive torque to close its contacts only when the other coil gets a voltage $\overline{OR}$ across it. The positive torque range is shown by the shaded angle. The other relays will have a negative torque tending to keep the relay contacts open. Each relay thus selects the faulty phase, which is at once indicated on the faulty phase indicating lights (10).

As soon as one of the supervising relays closes its contacts, a corresponding time delay contactor in the relay combination (10) is energized. The time delay for the contacts to close is about 0.3 second.

Earth leakage relay operation—As soon as one of the contactors of the relay combination (6) closes its contacts, the loading contactor (8) is energized and its contacts close. This introduces the loading resistance (5) to the quenching transformer secondary. The resultant current is transformed to the primary and flows

as an additional watt component of the fault current over the fault spot as shown in Figure 7.

Other set of auxiliary contacts of the contactor in (6) energizes the fault voltage bus to which the voltage coils of all the earth fault relays are connected.

The relay in the faulty feeder thus gets the fault current in its current coil and the earth fault voltage across its potential coil. The vector relation between the current and the voltage in the relay in the faulty feeder is such that the relay has a positive torque which closes its contacts. Other relays in the healthy feeders have negative torques and therefore are automatically locked out.

With the closing of contactor (8), the time switch (7) and the hooter are also energized. The time switch (7) has 0-5 seconds time adjustment. After its set time-delay, the contactors of the relay combination (6) drop out, as their coil is disconnected over the normally closed contacts of (7) which open the circuit. Thus the loading resistance is again disconnected from the system. The faulty phase indication is, however, maintained and the time relay (7) held in over its holding contacts as long as the earth fault on the system persists.

Selective feeder fault indication—The system is designed such that earth faults on the outgoing feeders are selectively only indicated but the faulty feeder is maintained in service.

The feeder earth fault relay (12) of the faulty feeder closes its contacts during the short interval the loading resistance is introduced. The relay energizes an auxiliary contactor, which at once gives the earth fault signal for the feeder on the indicating lamp (13). The earth fault indication is maintained as long as the fault persists and the faulty feeder is not removed from service.

Generator earth fault protection — The generator earth fault relay (11) is arranged for tripping the main generator switch and introducing the generator de-excitation simultaneously.

The fundamental features of the machine earth fault protection is that the maximum extent of the winding shall be protected, and that the fault shall be cleared as quickly as possible. It means that the wattmetric relays should be designed as sensitive as possible. With present-day design technique, there can be no limit to the sensitivity of a relay. However, from the point of view of stability, it is desirable that the sensitivity is not pressed too high, as otherwise false indications, which could possibly be caused by system unbalance, may give false relay indications.

The earth fault relays are normally designed for about 1.0 watt sensitivity, i.e., with 100 volts impressed on its voltage coil, the relay can operate for 0.01 amp in the current coil. The loading resistance (5) is so selected that it would give about 70 per cent protection to the generator winding.

However, to increase the range of winding protection without raising the sensitivity of the ground fault relay, the loading resistance is automatically reduced if the fault lies within the remaining 30 per cent range of the winding. This is done over the voltage relay (6A) and the shorting contactor (8A). The voltage relay is set to open its contacts at about 35 per cent of the full phase voltage. When the fault lies within 35 per cent of the generator winding, relay (6A) keeps its contacts closed. This energizes the coil of contactor (8A) as soon as the loading contactor (8) closes. The superimposed watt component of the current during fault is thus kept to a value that would operate the earth fault relay positively.

To prevent pumping of the contactor (8A), its auxiliary contacts are so adjusted that if the contactor armature is slightly lifted, the auxiliary contacts make the coil circuit and pull the contactor in at once.

The recording voltmeter (9) gives a continuous record of the system neutral voltage.

The normal sensitivity of the earth fault selective relay is 1 per cent of the neutral point voltage for an earth fault at the generator terminals. The earth fault indication can therefore be given up to about 99 per cent of the generator winding.

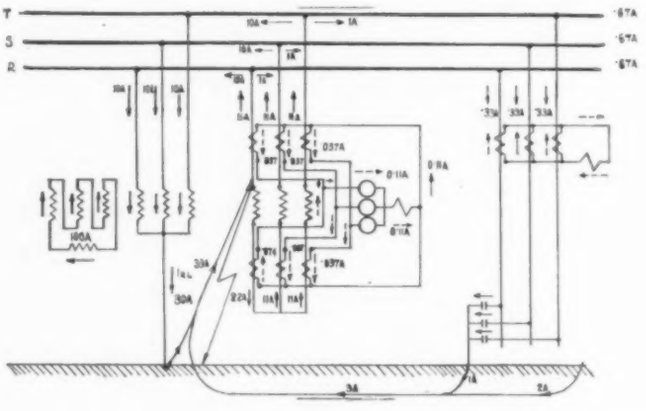
The positive power for the selective contactors in relay combination (6) is taken over instantaneous normally closed contacts (18) in the generator overload relays. This precaution is provided to make the earth fault relaying ineffective in case of heavy unbalanced faults in the system.

Surge arrestors — Surge arrestors (16) suitably graded and surge counters (17) are connected to the main bus as well as to generator neutral. This is to safeguard against probable voltage surges due to switching operations, if the switchgears are prone to current chopping, or due to voltage reflection at the generator neutral under unforseen extreme unfavorable conditions. This is merely an additional safety feature against extreme emergencies.

CONCLUSION

The system proposed provides all the advantages of a compensated reactance neutral earthing system even for a limited high tension distribution network transmitting power at generated voltage. The generator is fully protected up to 90 per cent of its winding. The ground fault selection relays operate up to 1 per cent of the neutral voltage so that the earth fault indication is given even if the fault lies very near the gener-

Figure 7 — Flow of watt components of current when the quenching transformer secondary is connected to loading resistance carrying 100 amp. In case of a generator ground fault, generator C.T. ratio is 300 to 1 and quenching transformer ratio is 10 to 1.



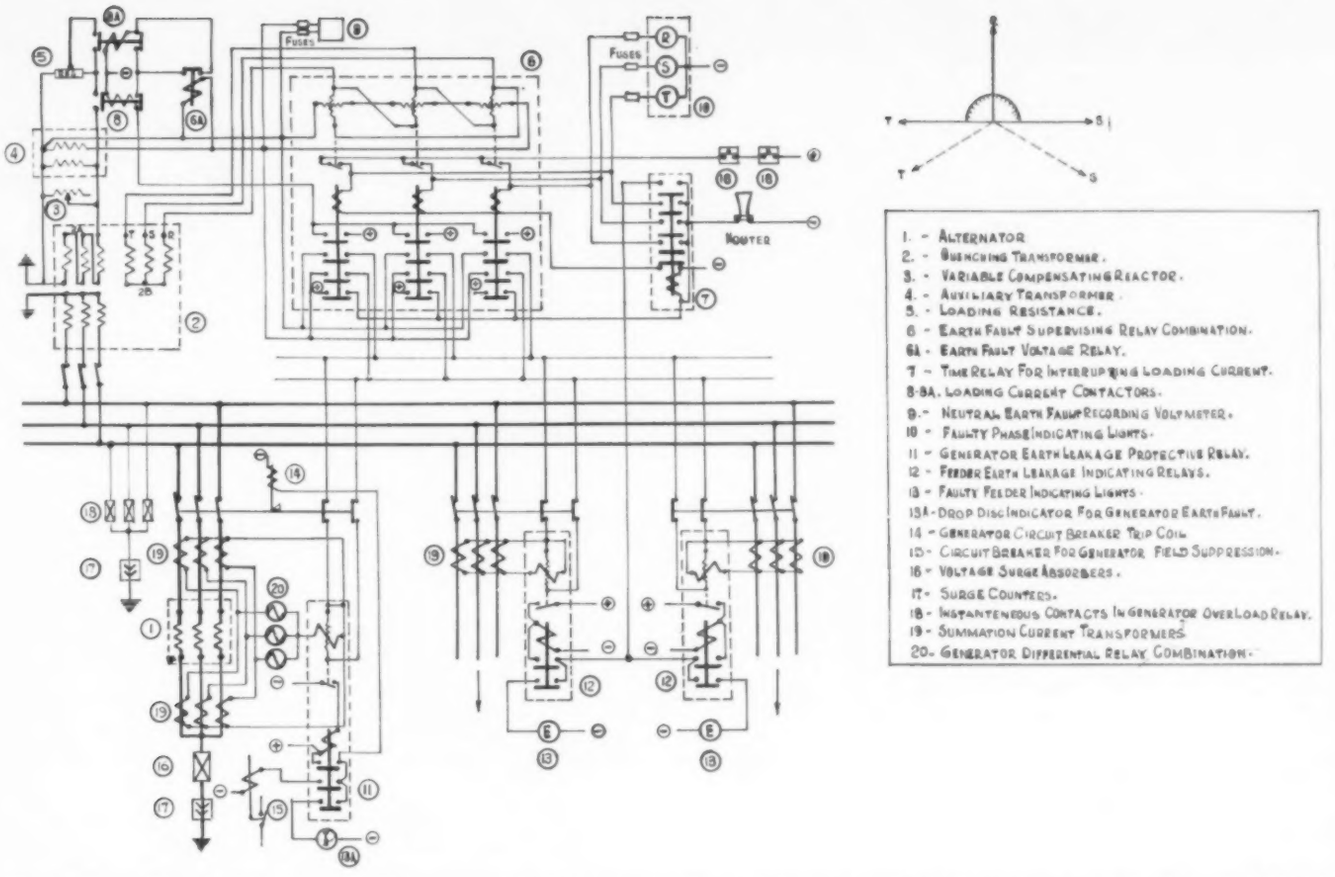

Fuses
Fuses
Rooter
1. - Alternator
2. - Quenching Transformer.
3. - Variable Compensating Reactor.
4. - Auxiliary Transformer.
5. - Loading Resistance.
6 - Earth Fault Supervising Relay Combination.
6A - Earth Fault Voltage Relay.
7 - Time Relay For Interrupting Loading Current.
8-8A. Loading Current Contactors.
9.- Neutral Earth Fault Recording Voltmeter.
10 - Faulty Phase Indicating Lights.
11 - Generator Earth Leakage Protective Relay.
12 - Feeder Earth Leakage Indicating Relays.
13 - Faulty Feeder Indicating Lights.
13A - Drop Disc Indicator For Generator Earth Fault.
14 - Generator Circuit Breaker Trip Coil.
15 - Circuit Breaker For Generator Field Suppression.
16 - Voltage Surge Absorbers.
17 - Surge Counters.
18 - Instantaneous Contacts In Generator Overload Relay.
19 - Summation Current Transformers.
20 - Generator Differential Relay Combination.

Figure 8 — Circuit of the selective ground leakage protection equipment with alternators and feeders combined. In the upper right hand corner is shown a vector diagram for a single directional relay of the three pole ground fault supervising relay combination.

ator neutral. The machine is disconnected for winding earth faults up to 90 per cent.

In case of earth faults on the system, even with underground cable network, it is possible to operate with one phase grounded for a short while, because the actual fault current is only 3 to 5 per cent of the total charging current of the whole system. During the short period, say of 1 to 2 seconds, when the loading resistance is introduced for relaying purposes, current flowing over the fault is limited to about 30 amperes only. Thus the chances of phase to phase short circuits are very remote and it is possible to keep the faulty cable in service, increasing continuity of power supply to a great extent.

The damage to the equipment is also reduced to a negligible extent as the maximum earth fault current is limited to only about 30 amperes, remaining only for 1 to 2 seconds, depending on the time interval selected.

With a well-designed quenching transformer or Peterson coil, the possibility of suspected neutral inversion becomes very remote. As the quenching transformer is connected to the main bus, the system is always protected even if a machine trips off. This is not the case with resistance grounding, where only one machine is normally connected to earth, and if that machine were to trip off, the system remains ungrounded with possibilities of all the evil consequences of an unearthed system.

Though the insulation for a reactance earthing system has to be necessarily for full line voltage, it is always preferable to purchase equipment insulated for an ungrounded system to provide a safe margin for unforeseen eventualities. In the author's own concern, it has been a long standing standard practice to order all high tension equipment insulated for unearthed system, as that gives a good margin against high temperatures and humidity.

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CRACKING OF BUNKER C OIL FOR GASEOUS FUEL

By P. T. DASHIELL
Gas Consultant
United Engineers and Constructors, Inc.
Philadelphia, Pa.

. . . . the production of gas from oil has the advantage that there is no investment required in heavy mechanical equipment such as fuel bunkers, grates, conveyors, or ash handling . . . .

▲ THIS paper covers, in general, current practice in the cracking of heavy fuel oils, usually designated Bunker oils, to produce gaseous fuel. Since steel men are more interested in the production of gaseous fuel of calorific value of around 1000 Btu per cu ft, the apparatus and procedure used in gasifying oil to make town gas will be but briefly described. In most cities where gas is manufactured, gas of 500 to 600 Btu is distributed and consists of either coke oven gas made entirely from bituminous coal, or carburetted water gas (using coke and oil), or mixtures of the latter and coke oven gas.

The first gas production in this country was entirely coal gas made by distillation of bituminous coal. It was used entirely for lighting. Its quality was determined on its luminosity when burned in flat flame burners, in its ability to give light, i.e., a candle power basis. Its illuminating value was from 14 to 16 candle power.

About 1880 Professor T. S. C. Lowe of Norristown, who previously had been the only aeronautical expert, i.e., balloonist in the Union Army, brought into commercial use the carburetted water gas process using coke and a petroleum product (at that time petroleum naphtha) capable of producing gas of any illuminating value up to 40 or more candle power, in a relatively low cost apparatus—requiring but a fraction of the labor required by a coal carbonizing plant. This was a great improvement in the art. One large company incorporated that word improvement in its title and made a great success because of its possession of Lowe's patents.

Presented before AISE Philadelphia District Section Meeting, November 6, 1948

THE CARBURETTED WATER GAS PROCESS

This is a purely chemical process in which steam and incandescent carbon are combined to make blue water gas mainly hydrogen and carbon monoxide, which is then mixed with the gases resultant from the pyrolysis or heat cracking of hydrocarbon (oil).

Because of the absorption of heat in the process of making blue water gas and cracking the oil, and because all heating is done internally, the heat up and gas making cannot be carried on at the same time. Therefore, the process is cyclical—alternate heat up and gas production.

From the commercial beginning, the hydrocarbonaceous material used in this process has been petroleum in some form, naphtha, gas oil, crude oils of certain types and in recent years heavy fuel oils.

The following is an excerpt from the paper entitled "Carburetting Blue Water Gas With Heavy Fuel Oil," by P. T. Dashiell presented at a joint conference of the Institute of Petroleum and the Institute of Fuel on Modern Applications of Liquid Fuels, September 21-23, 1948 at Birmingham University, England.

The term heavy fuel oil is used to describe the refinery residues which are generally used as industrial or bunker fuel, but in this case is limited to oil of bunker "C" specification of viscosity about 300 on the Saybolt Furol Scale at 122 F or higher, and distillation residue, 4 to 12 per cent (Conradson carbon).

"Most of these heavy oils leave, upon distillation, a relatively large coke residue; gas oils do not. High-coke oils, if used in a conventional water-gas set, deposit coke in the carburetter checkers to such an extent as

to make the set inoperable in a few days. The main problems in carburetting with heavy oils are the disposal of the coke residue with a minimum of lost time in set operation; to obtain sustained operation of the set over long periods of time at high rates of production; and to produce a by-product tar of satisfactory quality. This problem has been successfully solved and heavy oils are now used quite generally in the United States. Substantial financial savings have resulted because of the large difference which existed in the price of heavy oil and gas oil between the years 1928-1947. Now, in 1948, this difference is much less.

"Heavy oils, due to their high viscosity, cannot be successfully handled in tankage and pipe lines of gas works designed for use with gas oil. The paper describes proven methods of successfully storing, heating, pumping and spraying this class of oil.

"Concisely, the successful use of heavy oil requires that the coke residue resulting from the distillation of the oil shall be deposited in such a way that, in addition to making sustained operation possible, carbon is contributed to the process during both run and blow periods. This is accomplished, partly by making use of the heat of the top of the generator fuel-bed and partly by introducing the oil into the carburetter in a finely divided condition using a high pressure mechanical spray nozzle."

The types of oil available to the gas manufacturers today are vastly different from these obtainable 25 years ago.

The pyrolytic cracking of oil means a rearrangement of the molecules of the oil so that all or a large percentage of them will remain in gaseous form at any temperature and pressure to which they may be exposed prior to their combustion as a fuel.

In petroleum oil there are four general classes of hydrocarbons — aromatics, olefins, naphthenes and paraffins.

The paraffin class upon cracking yields the largest percentage of gaseous material of high calorific value; those of naphthenic type, the next largest. The yield from aromatics and olefins is very low because when cracked the resultant materials are mainly carbon and hydrogen.

Gases resultant from cracking paraffinic oil and to a lesser extent that of the naphthenic class are of high calorific value and relatively high specific gravity, 0.75-0.85 that of air. To obtain the highest yield of such gases the oil used must contain a high percentage of the paraffin—naphthene class.

In cracking most oils except those which are entirely paraffinic, certain materials condensible well above atmospheric temperature are produced. These are known as tars. These have a higher specific gravity than the original oil—a higher carbon hydrogen ratio—are not susceptible to gasification by further cracking to yield a gas of calorific value higher than that of hydrogen. They are useful in many ways as a liquid fuel, for road surfacing, for distillation into various tar oil fractions having a multitude of uses.

This material is mentioned here because its production is a part of the heat cracking gas of all oils except those of pure pariffin type such as natural gasoline.

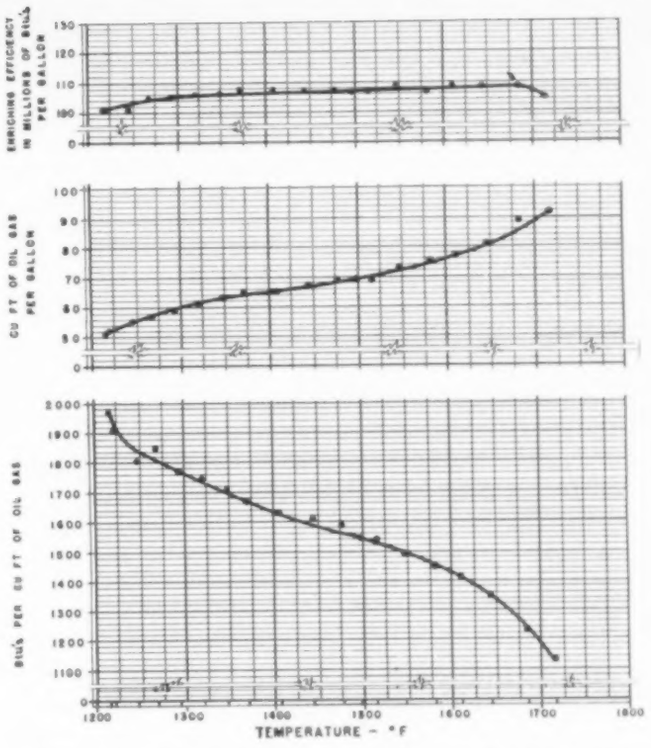

Figure 1 — The graph gives a good picture of the effectiveness of an enriching oil in a carrier gas.

Table I shows the characteristics of a number of heavy fuel oils and two gas oils.

Attention is called to the Conradson carbon and viscosity of the fuels as compared with gas oils. These are important features and will be discussed further on.

Please note also the so-called enriching value of these various oils.

By the term "enriching value" is meant the amount of increase in heating value of a given carrier gas—hydrogen or blue gas having a calorific value of about 300 Btu per cu ft—obtained when cracking a measured quantity of a given oil in the presence of a measured volume of carrier gas. It is usually expressed in terms of thousands of Btu per gallon (care must be taken to distinguish this figure from that for the total heating value per gallon of the same oil in complete combustion).

Figure I shows one method and a very efficient one of showing the enriching value of a given oil.

The apparatus used in securing the data consists of an electrically, externally heated quartz tube about 1½ in. diameter—through which the oil vapors (uncracked) and the carrier gas are passed at varying temperatures—means for measuring the rate and quantity of oil input—of carrier gas volume of predetermined calorific value— of cracking tube temperature —of the volume and calorific value of the final mixture —and tar production.

HIGH BTU OIL GAS

So far the carburetted water gas process and the pyrolytic gasification of oil have been briefly discussed.

TABLE I

	Fuel oil straight-run reduced crude	Bunker "C" fuel oil purchased for fuel with no specifications except those relative to its class as a fuel oil		Results of 6 months' operation of water-gas plant using an oil of bunker. "C" type (Total gas made—3,031,020 thousand cu ft)	Cracking plant tar	Straight-run residue too viscous to be sold under fuel oil specifications	Gas oil of fair quality	Oil of unusually high carburetting quality	Fuel oil "X"	Fuel oil "Y"	Fuel oil "Z"
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Specific gravity	0.933	0.955	0.972	.....	1.024	0.996	0.908	0.8226	0.914	0.935	0.967
Gravity, deg A.P.I.	20.0	16.6	14.1	14 to 17	3.4	10.6	24.2	40.2	22.3	19.7	14.7
Flash point (open cup), F	160	....	....	Above 150	....	....	175	....	210	250	345
Coke, per cent	7.5	10.4	10.1	7 to 8	8.4	10.0	1.6	0.01	4.84	5.06	7.14
Sulfur, per cent	2.1	1.2	2.5	0.3 to 0.5	1.43	3.09	0.45	....	2.17	1.67	0.68
Viscosity at 122 F., Saybolt-Fural seconds	70	280	284	Within bunker "C" limits, i.e., not over 300 sec Saybolt-Fural, 122 F	21	1.892	13	....	18	53	281
Distillation (F):											
to 400	8.0	1.0	....	1.0	Trace	Trace	1.5	1.8	1.0	....	....
400 to 450	3.7	1.0	....	2.0	1.0	....	4.2	1.5	3.5	0.7	....
450 to 500	4.5	2.0	1.1	1.5	6.2	0.5	8.6	3.0	6.5	2.5	0.9
500 to 550	5.3	3.0	4.4	5.0	10.0	0.5	13.0	7.4	8.5	6.0	2.7
550 to 600	8.3	8.0	7.0	14.0	13.4	5.0	13.0	22.9	17.0	19.0	57.7
600 to 650	61.7	65.0	21.1	46.5	10.2	64.5	10.9	34.4	54.0	51.0	15.6
650 to 700	....	3.0	28.4	15.0	35.0	16.0	41.0	21.2	2.0	8.0	8.5
700 and above	....	4.0	26.9	4.0	11.5	....	6.0	7.1	2.5	7.0	5.2
Total	91.5	87.0	88.9	89.0	87.3	86.5	98.2	99.3	95.0	94.2	90.6
Hydrocarbons:											
Aromatics, per cent	8	....	8	8	12	8	8	2.0	10.0	8.0	10.0
Oletins, per cent	24	....	28	28	44	28	8	0.0	16.0	24.0	26.0
Paraffins, per cent	54	....	45	50	25	48.8	63.8	85.7	62.0	53.0	48.6
Naphthenes, per cent	14	....	19	14	19	15.2	20.2	12.3	12.0	15.0	15.4
Carburetting value by computation	86.0	....	80.2	83.4	67.1	80.17	104.2	116.8	93.2	88.3	83.2
Carburetting value by laboratory set 1.000 Btu per gal	87.3	87.0	86.0	91.4	67.0	....	105	122	104	104	96.5

It is possible to make oil gas without the diluent of blue gas which will have a calorific value of about 1000 Btu per cu ft, i.e., about the same as that of natural gas.

In this process the equipment looks very much like that shown for carburetted water gas. In fact many of the plants making such gas today are simply rearrangements of water gas apparatus.

Gas of this kind is being produced in several situations at this time—except for two instances, it is used in conjunction with straight natural gas distribution. In this process the cracking of the oil is accomplished as previously described. No solid fuel is used. The heating is done by means of an oil burner or burners and air blast. The process is of course cyclical. Where low cost plant and high Btu gas are desired it has great advantages.

There is no solid fuel required—consequently no investment in fuel bunkers—conveyors or ash handling equipment—no expensive mechanical generator grate for ash removal from the fuel bed or expensive hand labor for the same operation.

The quality of oil gas produced is very similar to that produced when oil is cracked in the carburetted water gas process for the enrichment of blue water gas.

The process of producing high Btu oil gas and the fundamentals thereof are not new. A very similar gas known by the inventor's name Pintsch gas was made as far back as 1873. It was used largely to increase the illuminating value of retort coal gas and in this country as a high candle power compressible gas for lighting railroad passenger cars. In modern practice there are certain new features in the design of apparatus and objectives in utilizing the gas. There are several relatively new arrangements of apparatus for this purpose.

Figure 2 shows one of these—a rather simple one easily produced by rearrangement of the connections between the shells of a water gas set. The direction of flow of air blast during the heat up and gas during the production period is one way—no reversal—no regenerative effect. The temperature of blast products and gas leaving the set are high with consequently high heat losses—efficiency, i.e., heat input compared to heat in recovered products of the order of 75 per cent.

As already discussed—because the oil is vaporized and cracked by direct contact with brick heating surfaces—for smooth and efficient operation, with maximum working hours per day, this apparatus requires the use of an oil of low Conradson carbon. Therefore, in all the installations now in use, gas oil is used. Because gas oil is priced above heavy fuel oil and because

the yield of tar is lower than from fuel oil—the tendency is for a higher operating cost of gas than can be obtained from another arrangement of equipment shown in Figure 3.

This arrangement of equipment is of four shells so connected that oil is sprayed during a make period in the top of one shell and passes in one direction through the cracking surfaces of another shell. A blasting period follows with the flow in the same direction. The preheated blast air burns off the carbon deposited by the vaporization and cracking of the oil during the previous make period. Then follows a make period in the opposite direction followed by a blow period in the same direction as the make.

The outstanding features of this arrangement are:

1. It is regenerative, thus saving heat and restoring it for useful work in the process.
2. Preheat of air and steam aid materially in using up and thus removing from the cracking surfaces the carbon deposited by vaporization and cracking of the oil.
3. The oil cracking surfaces are so presented as to obtain conditions most favorable to efficient oil cracking. The operating cycle is of four minutes' duration in each direction.

The cracking temperatures are varied slightly depending on the type of oil used. The average temperature maintained at the bottom of the superheaters (the control point) is approximately 1600 F. The top superheater temperature averaged approximately 1200 F, due to the regenerative cycle and this resulted in considerable heat economy.

The blast rates used were approximately 16,000 cfm primary air at the top of the superheater and 12,000 cfm secondary air at the top of the generator, making a total blast rate of 28,000 cfm. The steam rates used are approximately 90 lb per minute during the oil injection period and 200 lb per minute after the oil injection period. The higher rate is used to purge the set as rapidly as possible before the blast period.

This process is a recent development making use of well known principles in a new way—with the objective of lowering operating cost and making possible the use of charging stock of lowest price.

The development has been one of the projects of the American Gas Association's Gas Production Research Committee.

After a year spent in full scale plant demonstration of its performance under test conditions in a large gas works where all input quantities were accurately determined, and production of gas and tar measured and quality tested; it has been shown that the process will work smoothly and continuously without interruption from carbon deposit with any oil from gas oil to fuel oil having up to 13 per cent Conradson carbon. A paper read before the American Gas Association Technical Section on October 5 shows the results obtained during the test work.

A summary of the oils used and the test results is given in Tables II and III.

Figure 2 — Flow diagram of twin generator oil-gas process.

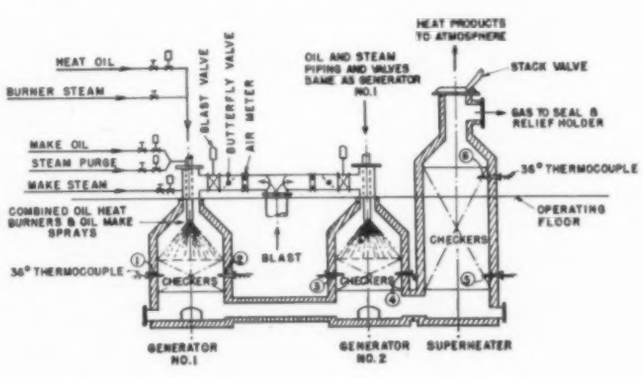

TABLE II — OIL ANALYSIS

Conradson carbon, per cent	0.20	3.16	6.02	13.03	12.56
Ash content, per cent	0.02	0.01	0.04	0.16	0.16
Enriching value, M Btu per gallon (Dick Method) (avg of 1400, 1500, 1600 F results)	103.6	98.8	102.5	93.8	95.2

TABLE III — OPERATING RESULTS

Btu of gas per cubic foot	1046	1006	1047	966	974
Specific gravity of gas	0.855	0.866	0.834	0.867	0.833
Gal heat oil per MCF+	0.99	0.80	0.95	0.28	0.69
Gal make oil per MCF+	11.50	11.46	10.67	11.69	13.31
Gal total oil per MCF+	12.49	12.26	11.62	11.97	14.00
Gal tar per MCF+	2.56	2.73	2.30	2.63	*
Gas made per day, MCF+	5,952	5,088	5,088	3,576	3,504
Thermal efficiency, per cent	79.2	80.9	81.8	80.6	.....

*Tar measurement lost due to stills boiling over.
+1000 Btu basis.
Thermal efficiency is of the order of 81 per cent.

A typical analysis of the gas from either of these oil processes is given in Table IV.

TABLE IV

Per cent CO_2	4.2
Per cent Illuminating	24.8
Per cent O_2	1.5
Per cent CO	3.4
Per cent CH_4	30.1
Per cent C_2H_6	7.9
Per cent H_2	16.8
Per cent N_2	11.3
Total	100.0
Per cent inerts	17.0
Calculated Btu	1065
Daily Btu (from calorimeter)	1063
Specific gravity	0.869

In round figures, using an oil having about 100,000 Btu per gallon enriching value and making gas of 1000-1100 Btu per cu ft, the following consumption of oil per MCF gas produced may be expected.

Gal of oil for heating—0.7 to 0.8 per MCF gas

Gal of oil for gas production—10 to 12 per MCF gas

Tar produced—2.3 to 2.6 gal per MCF.

A set of equipment made up of a shell of 11 ft outside diameter may be expected to produce daily from 5000 to 6000 MCF per day. These figures are quoted on

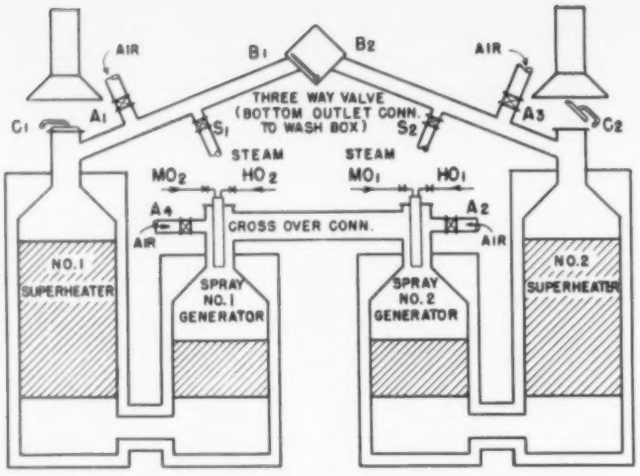

Figure 3 — The oil-gas process illustrated in this diagram gives a cheaper gas than that which would be obtained from the process in Figure 2, when gas-oil is priced above heavy fuel oil as is normally the case.

approximate high and low limit basis. Because the rate of oil consumption per MCF and rate of production vary with the quality of the oil feed, no precise figures can be quoted without definite knowledge of the specifications of the oil feed stock.

DISCUSSION

PRESENTED BY

P. T. DASHIELL, Gas Consultant, United Engineers and Constructors, Inc., Philadelphia, Pa.

J. H. Kerrick, Research Engineer, Philadelphia & Reading Coal & Iron Co., Philadelphia, Pa.

A. J. FISHER, Assistant Chief Engineer Construction, Bethlehem Steel Co., Bethlehem, Pa.

N. C. BYE, Chief Engineer, Henry Disston & Sons, Philadelphia, Pa.

Member: What is the temperature and the pressure of the steam entering into that system?

P. T. Dashiell: Low pressure steam can be used. It is common to use 10-lb steam, or less. Of course, that means larger connections to admit of the passage of the steam. If live steam is used, the connection is much smaller. The temperature runs about 1600 F in the bottom of the cracking shells and 1200 F at the top.

J. H. Kerrick: I presume all the work being done on the high Btu gas is for the purpose of lowering the price of the gas. I am wondering if you have made any study of the advantages of the use of oxygen, to further increase the capacity?

P. T. Dashiell: There has been a lot of study on the use of oxygen, but the trouble is the load factor of the average gas company. You cannot use oxygen if you have a low load factor on the oxygen plant. You must run it a very large number of days a year, and gas companies are not built that way, having a load factor of around 42 per cent. It is only the largest companies, as I see it who are going to get anywhere with the use of oxygen in making town gas. Of course, that does not apply to the chemical industry. They have, or can have, a high load factor on their equipment, and oxygen, of course is going to save money on the production of blue gas. It probably has not arrived in combination with the making of carburetted water gas, because in oxygen production of blue gas, you will probably have a balanced performance and continuous evolution of blue gas, and you have a cyclical evolution of oil gas, and you have to bring the two together. It may come, however, it has not yet.

J. H. Kerrick: What about pressurized burning?

P. T. Dashiell: They do have a project that has been worked at for some three years, varying pressures and conditions, but they have not any answer that I can give you at this time. I think the chances are that up to a certain point, the capacity would be increased, but, of course, you then get into an entirely new type of apparatus and present--day shells are not built for anything like that.

A. J. Fisher: What would be the effect of preheating the steam to 1600 F by means of powdered coal, or some other cheap solid fuel, to increase the oil efficiency, and thereby lower the cost of the gas?

P. T. Dashiell: That is all right, if you want to handle solid fuel. But it does not cost so much, this is a pretty cheap way to do it. The big advantage of the Lowe system of operation which put out of use all the other methods of making carburetted water gas was that he did all his heating internally, by direct combustion of the gases from the fuel beds generated in the heating up portion of the process. Some had the blue gas generator separate from the oil cracking equipment, and would bring it back and vaporize the oil in another vessel and so on, and the cost was much too high.

N. C. Bye: In your paper you described some of the operating economies the gas producing companies are putting into effect. I would like to know if you care to guess as to whether in the future, these changes will result in a more or less favorable Btu cost ratio between gas, oil and coal.

P. T. Dashiell: The mantle of prophecy has not fallen on my shoulders, but I think it fairly obvious that coal and oil are certainly in direct competition with each other. The oil man is going to consider 3½ barrels of oil equivalent to a ton of coal. If you start in with the cost of a ton of coal, you can figure where your oil price is going to be. Above that is the cost of converting the oil or the coal. Of course, the gas companies are conserving town gas and have increased prices far less than the purveyors of other fuels, and they are all, throughout the country, in more or less trouble for that reason. They are not going to stay there. There is no reason the price of gas should not go up along with the raw materials of manufacture, as well as with such things as coal and oil, but the advent of natural gas on the seaboard here, has provided a therm of heat which is far lower in cost at the present time than a therm from either coal or oil. That puts an indication of hope into the picture, that the cost of gas will come down from where it is now, but the current price of gas is not high enough, and you might as well get that very clear in your mind.

CRACKING GASOLINE FOR GASEOUS FUEL

By T. F. LOUGHRY
Gas Production Div.
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. . . . under conditions where a plant may expect gas shortages, it may be economical to install standby gas-making equipment when curtailment of production is more expensive than the capital charges involved in maintaining a standby plant . . . .

▲ ALTHOUGH this paper is titled "The Cracking of Gasoline for Gaseous Fuel," the equipment which will be described can also be utilized for cracking any of the lighter hydrocarbons down to and including natural gas. The process as it exists today is a direct result of research and development by the company with which the author is associated in the field of gaseous atmospheres for controlled metallurgical processes.

The development which led to the present design began in 1935 with the delivery of two units capable of producing a blue water gas from kerosene. These "pyrol" units produced a clean carbonaceous gas to be used for the carburization of steel in a locality where no propane or natural gas was available. They were of 6-tube horizontal type in which the three lower tubes were used for producing the equivalent of a Pintsch gas, the three upper tubes cracking this gas at high temperatures into the blue gas. The gas was then washed before use in the carburizing furnace. No added catalyst was used, the steel of the cracking tubes performing this function.

After about six years of continual research, the first fully successful prepared atmosphere gas generator utilizing a nickel catalyst was put into operation, again for carburizing. Termed an "RX" unit, the generator produced 500 cfhr of a producer gas made from natural gas. This gas was slightly enriched by additions of propane to produce the desired carbon potential for the carburizing operation. Since that time numerous RX generators of various capacities have been built and placed in operation in carburizing and metallurgical plants throughout the country.

During the period devoted to the design and testing of this first RX generator, the possibilities which might be made available to gas utilities by units of much larger capacity became apparent. It seemed to be obvious that an entirely new approach to the utility peak-load problem could be made if hydrocarbons heavier than natural gas could be cracked successfully in a process which did not simultaneously create quantities of carbon and tar with the attendant removal and disposal difficulties. Further research work was conducted with a pilot unit of substantially the same design as the RX generators. Another three year period elapsed before results were obtained which were sufficiently conclusive to justify suggesting this method to the gas industry.

In September 1944, a sample of the city gas manufactured by the Washington Gas Light Co. was obtained and analyzed. Shortly thereafter the catalytic cracking process was discussed with officials of this company and a definite proposal for a 16-tube plant was prepared and submitted. This plant was subsequently ordered and shipped to Washington but was never placed in operation at that location because natural gas was made available in sufficient quantities to permit changing the entire system to straight natural.

Concurrent with the negotiations with the Washington Gas Light Co., the Institute of Gas Technology presented proposals to the American Gas Association for research in the field of catalytic cracking. The research program was finally approved and, in the early part of 1947, a 2-tube modified RX unit was placed in operation at the Chester plant of the Philadelphia Electric Co. by the Institute of Gas Technology. This unit was used for conducting the research for the American Gas Association Research Committee and the results of this program have been extremely valuable in adding to the knowledge of the art.

Also in 1947, the plant originally built for Washington was purchased by the Long Island Lighting Co., increased from 16-tubes to 24, and installed at River-

Presented before AISE Philadelphia District Section Meeting, November 6, 1948

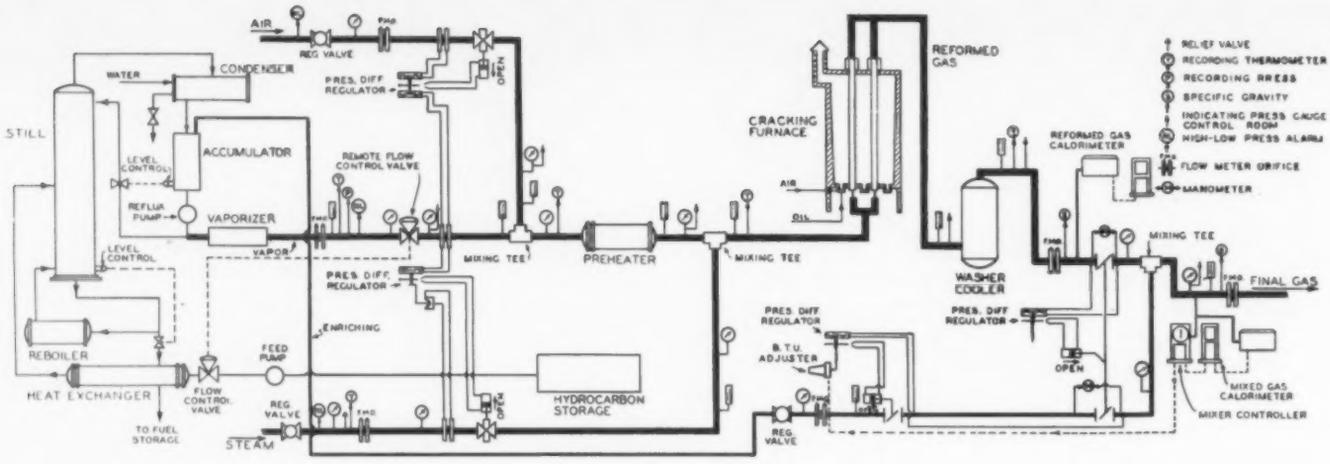


Figure 1 — Flow diagram of the gas making process.

head, Long Island. It went into operation late in 1947 and operated as a producing gas plant during the winter of 1947 to 1948, manufacturing a 540 Btu 0.67 specific gravity gas using propane as a feedstock. Currently two additional plants are under construction, one at Reading, Pa., and the other at Harrisburg. These plants will be in operation about November 15 and will produce a coke oven gas equivalent to 520 Btu, 0.52 specific gravity. They will be equipped to utilize natural gas, propane, butane, casing head gasoline, or straight run gasoline as a feedstock. A third plant will be constructed at Allentown, Pa., during the spring of 1949.

THE PROCESS

It will be noted from the preceding brief historical resume that the process under discussion has been developed primarily a standby or peak load equipment for the gas industry. It does have a field and has created considerable interest, however, in industry in general, particularly in localities where fuel gas curtailments are prevalent during the winter months. The following description of the process will cover a complete gas plant which would be designed for a utility bearing in mind the fact that certain simplifications could be made where a plant was to produce a gas for the owner's own processes and not for resale.

The essential justification for a catalytic process for manufacturing fuel gases results from the need of a process which will produce a substitute gas which is completely interchangeable with the gas obtained from normal sources. In order to meet this requirement, it is necessary that the process must be capable of controlling not only the heating value of the gas, but also the specific gravity. Unless both of these physical qualities are duplicated within rather close limits, the combustion characteristics of the substitute gas will vary so widely from those of the normal gas that serious utilization difficulties will result. The catalytic process possesses the ability to vary both the heating value and the specific gravity within wide limits so that it is possible to produce a gas which is interchangeable with almost any of the fuel gases in common use from coke oven gas to natural gas.

Five operations are necessary to produce the final gas when using gasoline as raw material.

1. Separation of the gasoline into three fractions by means of a suitable still.
2. Mixing the hydrocarbon gas vapor with air and steam in the correct proportions.
3. Cracking the mixture in the catalytic furnace.
4. Cooling the resulting reformed gas.
5. Enriching the reformed gas to produce a final gas of the desired heating value.

(1) When casing head or straight run gasolines are used, these feedstocks are first separated by a still and partial condenser into three fractions. The lighter fraction consisting of C_6 or lighter is used for cold enriching as a means of heating value control. The middle fraction, consisting of C_8 to C_6 is used as the hydrocarbon feed to the furnace and is cracked into a lean carrier gas. The remaining fraction is a still bottom residue suitable for use as fuel. These still bottoms are not suitable for cracking at the present stage of development because they have a tendency to deposit carbon on the catalyst and introduce operating difficulties.

(2) Since the composition and, more important, the specific gravity, of the gas produced by the cracking furnace depends upon the proportions of the air and steam fed to the cracking tubes with the hydrocarbon vapor, the terms "air-gas" or "steam-gas" are used, depending upon whether air or steam predominates in the mixture. By controlling the proportions of air and steam, the specific gravity of the reformed gas may be varied from 0.35 to 0.70 (air = 1). At the same time, the heating value will vary from 380 to 180 Btu per cu ft, the higher heating value corresponding to the lightest gas, and being obtained from 100 per cent steam-gas with no air in the mixture. The other limit represents the results obtained from the manufacture of 100 per cent air-gas. By changing the air and steam proportions, the specific gravity and heating value may readily be made any desired value between the above limts. By properly choosing the specific gravity of the product gas in relation to the enriching medium, it is possible to produce a final gas which will almost exactly match in Btu and specific gravity or at least

be interchangeable with almost any type of fuel gas in common use.

(3) After the proper amounts of steam, air, and hydrocarbon are mixed, the mixture passes into the catalytic cracking furnace which consists of a multiplicity of vertical heat resisting alloy tubes supported in a suitable furnace setting and heated externally by means of oil burners. The tubes are filled with a nickel catalyst supported by a porous refractory material. The mixture of gases, in contact with the catalyst at temperatures of 1650 to 1800 F react in accordance with the following equations:

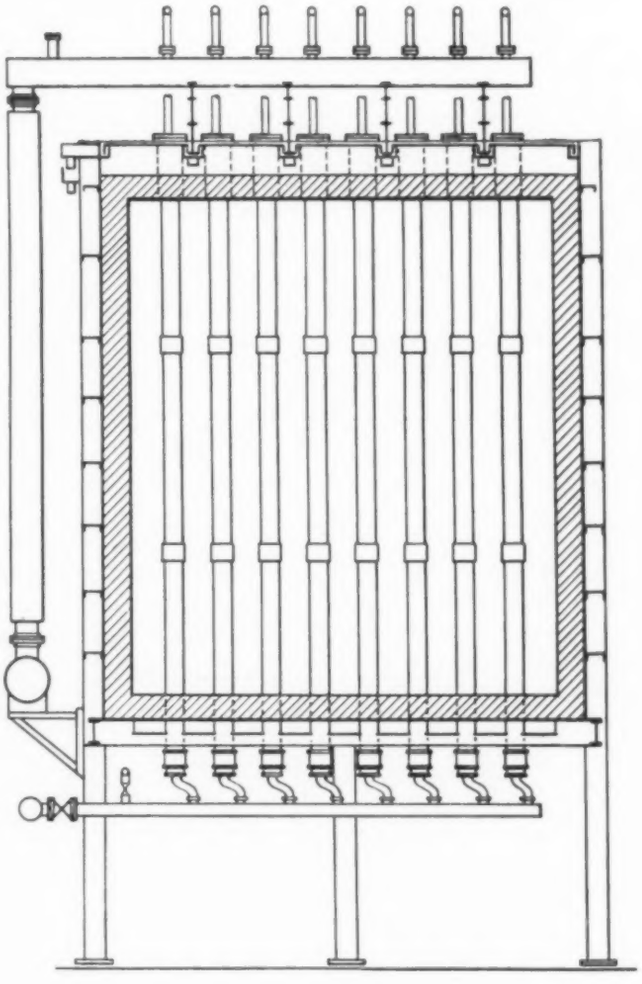
$$C_6\,H_{14} + 3O_2 + 11.4N_2 = 6\,CO + 7H_2 + 11.4N_2$$

$$\text{or } C_6\,H_{14} + 6H_2O = 6\,CO + 13H_2$$

These equations are based on reforming hexane. The other hydrocarbons react similarly. The first equation is typical of the air-gas reaction and the second of the steam-gas reaction.

In actual practice, the two reactions given above will not proceed to completion and small percentages of uncracked hydrocarbons, mainly methane, will be found in the reformed gas. Also a portion of the carbon is normally completely consumed to form carbon dioxide. It is, however, possible to control the presence of these gases to less than 8 and 5 per cent of the reformed gas respectively. The lower limts of these products depend upon a willingness to accept a decrease in the capacity of the unit. Generally speaking, their presence is not important where the unit is being operated to produce a fuel gas and the obvious tendency is to operate the furnace at its maximum rated capacity.

Figure 2 — Cross-section of a catalytic cracking furnace.



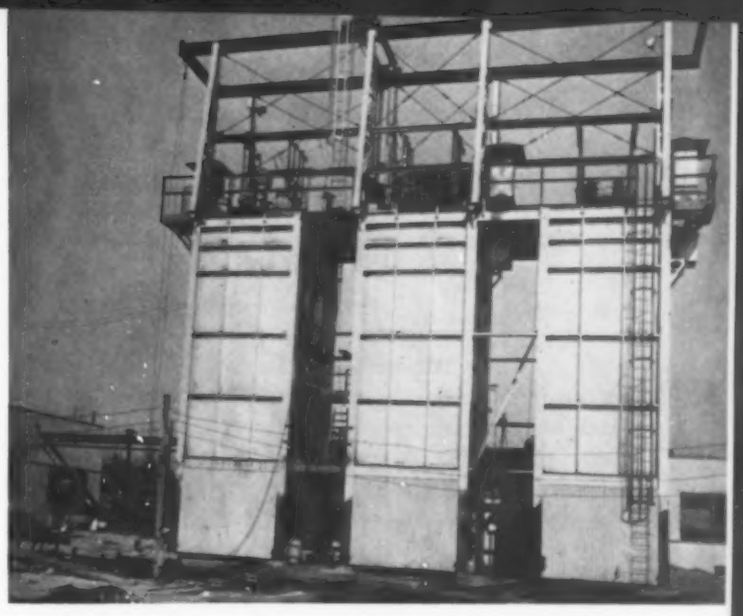


Figure 3 — The furnace installation at Riverhead, Long Island is a compact unit, as can be seen from the photograph.

(4) After the feed mixture has been cracked, it is collected from the bank of tubes by means of a number of water cooled collecting ducts and is delivered to a hydraulic main where primary cooling takes place. The hydraulic main delivers the gases to a cooling tower where it passes upwards over a series of wooden grids, and is cooled by direct contact with water admitted at the top of the tower through a series of spray heads. It should be remembered that the gas passing through the cooling tower is clean and contains no carbon or condensible vapors. There are, therefore, no end products requiring removal and disposal.

(5) Following the cooling operation the gas is enriched to the desired heating value by the addition of the light fractions from the fractionating column. The control is accomplished by means of a calorimeter which actuates a suitable proportioning device. The quantity of enriching vapor is automatically controlled with respect to the quantity of reformed gas passing through the mixing unit.

The matter of enriching with light gasoline fractions consisting of pentane, hexane and small fractions of heptane, introduces one problem if the gas is to be delivered to the distribution system at high pressures. At normal main temperatures of 40 F in cold weather, the above gases, at the percentages required for enrichment, will condense out at pressures above 7 to 8 psi gage. Where main pressures higher than this are encountered, it becomes necessary to use some other enriching agent such as propane or butane. These figures are based on the replacement of common manufactured gases with heating values in the vicinity of 520 to 540 Btu per cu ft. Where higher heating values are involved, the allowable main pressures become lower. At 1000 Btu per cu ft it becomes impractical to attempt to use the light ends of straight run gasoline as an enriching agent.

OPERATING RESULTS

In order to visualize the flexibility of the catalytic process, it might be helpful to consider operating figures from two typical gases: (1) carburetted water gas of 540 Btu 0.67 specific gravity and (2) coke oven gas of 520 Btu 0.52 specific gravity.

Gas number 1 will require about 5.86 gal of straight run gasoline per 1000 cu ft of final gas. Of the total gasoline, 2.39 gal represents the middle fraction used for cracking stock, 2.30 gal represents the top fraction used for enriching, and the balance of 1.17 gal represents the still bottoms used for fuel.

Gas number 2 will require about 5.29 gal of straight run gasoline per 1000 cu ft of final gas. Of the total, 2.58 gal represents the middle fraction used for cracking, 1.65 gal represents the top fraction used for enriching, and the balance of 1.06 gal represents the still bottoms.

Note that we have considered two gases of very nearly the same heating value but of considerably different specific gravities. In the first case, neglecting the still bottoms, approximately 50 per cent of the gasoline used for the process was cracked. In the second case, 61 per cent was cracked. The explanation is this. In order to manufacture a heavy gas as in case 1, about 50 per cent air-gas and 50 per cent steam-gas was manufactured. This gas had a heating value of 304 Btu and a specific gravity of 0.544. When it was enriched to 540 Btu, the heavy enriching gases raised the gravity of the mixed gas to 0.67. In case 2 the desired gravity of the mixed gas was lower, 0.52. The steam and air ratios were changed to produce about 90 per cent steam-gas and 10 per cent air-gas. The product, or reformed gas, had a heating value of 354 Btu and a gravity of 0.424. When this gas was enriched to 520 Btu, a smaller proportion of enriching gas was required and consequently the final mixed gas had a lower gravity—the result of a smaller percentage of enrichment and a lighter carrier gas to begin with.

In case 1, approximately 30 lb of reaction steam and 216 cu ft of reaction air were required per M cu ft of final gas. These figures compare to 35 lb of reaction steam and 30.4 cu ft of reaction air per M cu ft of final gas in case 2. The difference in the mixture going to the cracking furnace is more specifically shown by comparing the amounts of steam and air used per gallon of cracking feed in both cases. In case 1, each gallon of feedstock cracked was mixed with 12.5 lb of steam and 90 cu ft of air. In case 2, each gallon was mixed with 13.6 lb of steam and only 11.8 cu ft of air, an increase of 9 per cent in the amount of steam used and a decrease of 87 per cent in the quantity of air.

As a matter of general interest, each gallon of reaction hydrocarbon will produce approximately 395 cu ft of reformed gas in case 1 and 371 cu ft in case 2.

A further characteristic of the process is the variation in plant capacity as the percentage of steam gas increases or decreases. For example, the capacity of a given plant in terms of reformed gas when manufacturing a 50 per cent steam gas, 50 per cent air gas (case 1) will be approximately 30 per cent more than when manufacturing a 90 per cent steam gas, 10 per cent air gas. The explanation lies in the fact that the steam gas or water gas reaction is more highly endothermic than the air gas or producer gas reaction. Since the heat absorbing ability of the tubes is fixed, high water gas yields can be obtained only at the expense of slower travel and more time in the tubes.

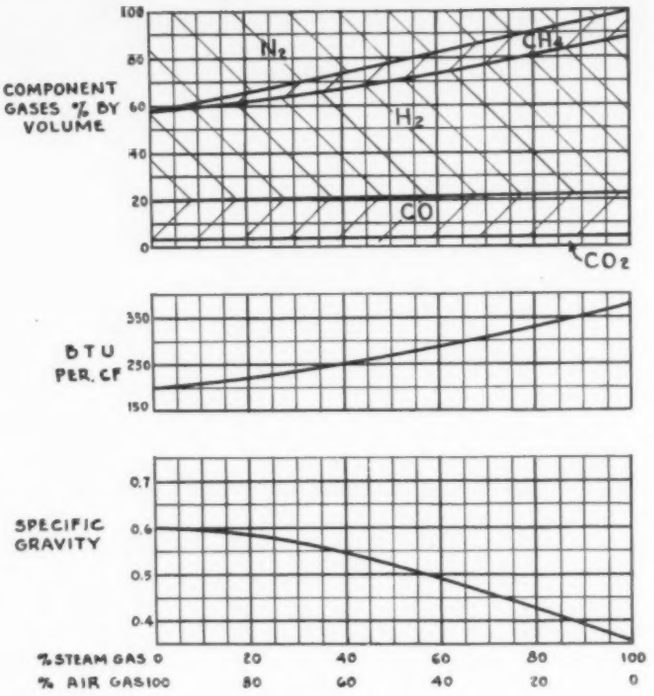


Figure 4 — The graph shows the product obtained from natural gas catalysis.

FEEDSTOCKS OTHER THAN STRAIGHT RUN GASOLINE

Mention has been made of the fact that natural gas, propane, butane, and casing head gasoline may also be used in this furnace. Propane and butane may be used directly by by-passing the still. They form excellent sources of raw hydrocarbons having only one disadvantage, the cost of storage in large quantities. They have the advantage that no difficulties are experienced as a result of condensate in the enriched gas lines under low temperature and high pressure conditions.

Casing head or natural gasoline of the grade commonly known as 26 RVP makes an ideal feedstock where available. The still would remain in use but the light ends consist of sufficient butane to eliminate the condensation problem at high pressures. Since casing head gasoline contains, as a rule, no hydrocarbon heavier than octane, practically all of the raw material can be used for either cracking or enriching and permits using a cheaper material for fuel.

The application of the catalytic process to natural gas areas is only now in the process of development. The process forms an ideal method for reforming of natural gas in territories where the system is not changed over to straight natural but is maintained on a city gas basis. In such cases, one cu ft of natural gas will yield approximately two cu ft of city gas with a

minimum expenditure for plant and labor. In natural gas areas, the process has an application as a means of supplying peak gas. In this case, the natural gas is cracked to a lean, low gravity steam-gas which is enriched back to 1000 Btu with propane or butane. By this method the volume can be increased about four times. The process therefore offers a relatively low-cost means of coping with natural gas shortages where peak demands will invariably be severe regardless of any increases in pipe line facilities in the future.

FLEXIBILITY AND SIMPLICITY OF OPERATION

Flexibility of operation may be considered as consisting of two factors. By changing the proportions of air and steam, the type of gas may be varied as desired. Second, the fact that the rate of output may be varied in direct proportion to the demand for finished gas, eliminates all need for a gas holder or other means of building up a reserve supply. The gas is made and supplied directly to the mains at the desired pressure regardless of demand within, of course, the limits of capacity of the installation.

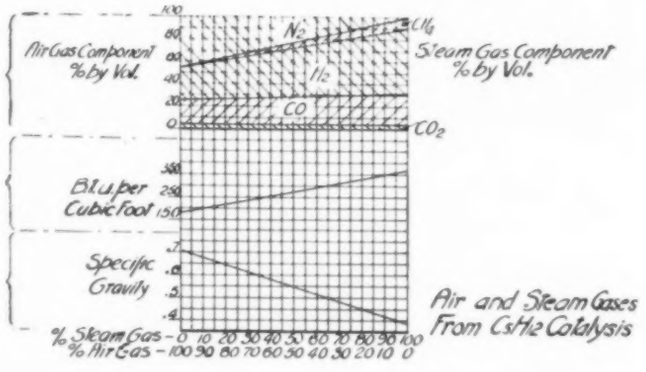
The control system is such that virtually complete automatic operation is obtained. The plant is controlled from a central control room which houses the instruments, meters, gages, etc. Automatic shut-down equipment is provided which not only shuts down the plant should there be excess pressure in the furnace system or any failure of supply of any of the three feed ingredients, but also sounds an alarm and indicates by means of lights the cause of shutdown. In addition, the alarm sounds if furnace temperatures exceed either a safe upper or lower limit as set on the control pyrometers.

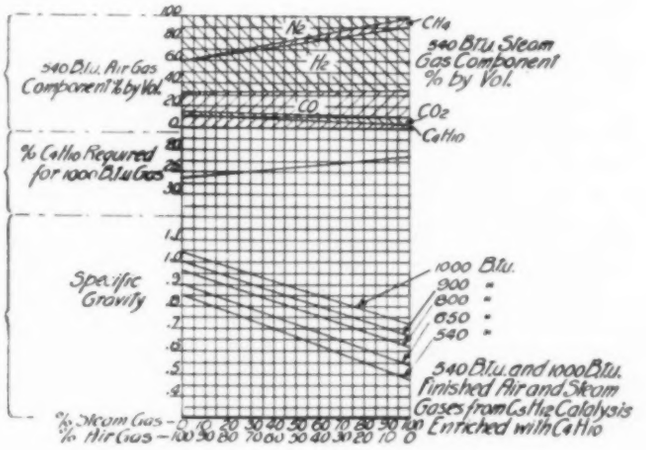
Plants of this type possess unusual compactness when compared with other methods of producing fuel gas. A plant to produce seven million cu ft of carburetted water gas per day requires a space of 18 x 25 ft. The still area requires 15 x 20 ft and the control room may be housed in a one story building 20 x 50 ft. Storage facilities for raw feedstock and fuel are the only other requirement. Smaller plants down to 8000 cfhr will, of course, require much less space.

CONCLUSION

It is not anticipated at this time that plants of this description will find a field in heavy industry where the cruder fuels may be used direct. Neither do they have a place in those plants which are now using liquefied petroleum gases as such. It is felt, however, that many industrial plants, particularly in the natural gas areas or in areas where shortages of manufactured gas are a seasonal occurrence, may find it economically feasible to install their own stand-by equipment on the basis that a shut-down or curtailment of production for even a short period of time will cost more than the capital charges involved in maintaining a stand-by plant. Obviously, the major number of installations will be made in the utility field where the community as a whole may be served with a minimum of investment per unit of capacity.

Figure 5 — Products obtained from cracking various gasoline feedstocks are given in these charts.


Air Gas Component % by Vol.
N2
CH4
H2
CO
CO2
Steam Gas Component % by Vol.
B.t.u. per Cubic Foot
Specific Gravity
Air and Steam Gases From Cat Hz Catalysis
% Steam Gas – 0 10 20 30 40 50 60 70 80 90 100
% Air Gas – 100 90 80 70 60 50 40 30 20 10 0


540 B.t.u. Air Gas Component % by Vol.
N2
CH4
H2
CO
CO2
CatHo
540 Btu Steam Gas Component % by Vol.
% CatHo Required for 1000 B.t.u Gas
Specific Gravity
1000 Btu.
900 "
800 "
650 "
540 "
540 B.t.u. and 1000 B.t.u. Finished Air and Steam Gases from Cat Hz Catalysis Enriched with CatHo
% Steam Gas – 0 10 20 30 40 50 60 70 80 90 100
% Air Gas – 100 90 80 70 60 50 40 30 20 10 0

DISCUSSION

PRESENTED BY

C. E. DUFFY, Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

J. S. MORRIS, Special Engineer, Lukens Steel Co., Coatesville, Pa.

T. F. LOUGHRY, Gas Production Div. Surface Combustion Corp., Toledo, Ohio

P. T. DASHIELL, Gas Consultant, United Engineers & Constructors, Inc., Philadelphia, Pa.

N. C. BYE, Director of Engineering, Henry Disston & Sons Co., Tacony, Philadelphia, Pa.

C. E. Duffy: Why is the nickel catalyst used?

J. S. Morris: At Lukens, we have been completely shut down, on occasions, due to a shortage of natural gas. How much are these units? In other words, what would your usage have to be to make them economically sound, as a complete replacement for natural gas?

Member: The paper dealt chiefly with the manufactured gas. At the present time the Philadelphia Gas Works is leading natural gas into their carburetted

water gas, in order to enrich it slightly. That is giving us some unnatural headaches. I am wondering just how we can go about burning this new gas they are giving. What are we going to do in order to burn the new as well as the old gas?

T. F. Loughry: The utilization of Philadelphia gas with a mixture of natural, is a little hard to answer without knowing at the moment just how much straight natural gas or how much reformed natural gas they are putting into the system. I do know they are adding some reformed gas. If they are getting enough reformed gas into the system to throw the gravity off, simply on the basis that cracking of natural gas gives a high hydrogen yield, it could change the combustion characteristics of the gas enough so that an adjustment of the present burners might be necessary. In general, I would say that the utilization of that gas is merely a matter of correcting in a rather minor way, the adjustment of the existing industrial burners, to take care of whatever changes have been made in the combustion characteristics of the gas—and almost any industrial burner should be flexible enough to take care of those changes. I do not know what kind of trouble you have had.

Member: The chief trouble is directing the gas flame directly onto the work. The new gas is slower burning.

T. F. Loughry: Do you know what percentage of natural they are putting into the gas?

P. T. Dashiell: I know something about that. Here is a plant which has made carburetted water gas and delivered that mixed with coke-oven gas for years. The water gas is carburetted with oil. With the advent of the natural gas, there is a brand new operation. Again, here is a plant delivering about one hundred million feet of gas a day that has to change the process over from no natural gas, oil carburetion, to reforming natural gas and reenriching that with other natural gas and has to adjust everything in the plants to the new conditions. The Town gas will not be radically different. You can imagine some experience is necessary for the big change-over from that kind of material. If you had trouble the chances are it is due to little faults in the operation of the plants of the Philadelphia Gas Works, which would be a perfectly natural thing to have happen. You could not expect a change over without having some slips in a plant of that size. But the final gas you are going to get is not going to be materially different from what you have had. I know that definitely, because up to the time of my retirement, from the company I did a lot of planning on this work.

What they are doing is taking a natural gas and substituting it for oil. A portion of it is reformed, over to about 400 Btu in the generators I have shown you, and that is enriched with other natural gas. You are right in saying it is probable that you have more slow-burning gases than you are used to. But it is only a matter of experience to wipe out the difficulties. It is not a new gas you are going to have at all. I do not think you are going to have any sustained trouble with it.

In answer to another question, I think they are reforming a larger portion of it and using the rest for cold enrichment—the mixture is coke oven gas, reformed natural gas, plus natural. The idea is substitution of natural gas for the oil, but not the delivery of the straight natural gas.

T. F. Loughry: Why a nickel catalyst was a second question. It so happens that nickel is the material that promotes most of the reactions we are after. Some other catalysts, on the other hand, have a tendency to promote reactions in just the opposite direction. The use of nickel for reforming of these gases is nothing new. It is old, it has been written up in the literature for years and years. All we have done is to adapt what was already known, to this particular type of operation.

And you mentioned, why did we not use something else such as an incandescent surface. Without a catalyst you are going into thermal cracking, rather than catalytic cracking, and when you go into thermal cracking, you cannot always control the direction of the reactions taking place. You get a reconditioning of some of the unsaturated hydrocarbons you make, in the breaking down processes, and are likely to get anything out of the reaction, from formaldehyde to all other kinds of gases that you do not want. All that the nickel does is to promote the reactions in the desired direction.

P. T. Dashiell: It is also true that the effect of the catalyst is to lower the optimum temperature at which you work very materially.

T. F. Loughry: That is correct. Another question was what would your usage have to be to make the plant economically sound. I would say that depends upon the local situation. In other words, considering a plant as a standby, in an industrial plant, the question is, how much does a plant shut down cost you, and how long a shutdown would you normally anticipate during the winter months?

In one case where you are only shut down for a couple of days, a standby plant might be justified because the cost of shutdown and starting up again, even though the loss of production may be negligible, is excessive. In another case it might require a considerable shutdown period before the loss of production could justify the plant. So, there is almost no answer to that question, without considering the circumstances surrounding individual cases.

It is also impossible to give any figures on the cost of a plant because they are designed with capacities from 4000 or 5000 cfhr up to 75,000 to 80,000 cfhr. The investment cost for a thousand feet of capacity is naturally going to be less for the larger plants, so the cost of the installation is a function of how much gas is required to satisfy the local condition.

N. C. Bye: In your paper you stress the economic advantages of the described equipment for stand-by purposes. Does this equipment also have an economic advantage in a direct cost ration with present standard sources of fuel supply, such as gas, oil, and coal?

T. F. Loughry: I think the question applied to whether or not catalytic cracked gas would be in a competitive market with oil and some of the other fuels.

I think I mentioned earlier in the paper that really the process has no application in heavy industry, where crude fuels can be used as such. As an example, consider a steel mill, where oil can be applied directly. The fuel utilization equipment consists of a relatively few very large furnaces. We will assume that those pieces

of equipment are using gas as a fuel, and that we are talking about a stand-by fuel. In such a case the equipping of that plant with stand-by oil furnaces would be much cheaper than to put in a catalytic plant. The use of straight fuel oil would be cheaper than catalytic gas because, even if we could reform fuel oil in the catalytic plant, which we cannot do today, obviously there will be a reforming cost. So a million Btu of fuel oil as it comes from the catalytic cracker would cost more than the raw material going in. Generally speaking, it is not economical to install a stand-by gas generator under such conditions, either from the standpoint of initial cost or operating cost.

Where a stand-by gas generator works in, would be in an industry that has a large number of small furnaces; each having a multiplicity of gas burners. Under those conditions, the difficulty is the expense involved in providing stand-by oil equipment. Also, this is sometimes physically impossible because in many cases the processes themselves cannot use oil. Under those conditions you can afford to momentarily, or for a few weeks, use a higher priced fuel, to tide you over instead of shutting the plant down.

We are now quoting a large automotive plant where they have exactly that situation. They have a large number of furnaces which would be small, as a steel industry considers furnaces, but they are still large users of fuel. Many of their furnaces could not possibly burn oil. They are in a territory that is faced with curtailment this coming winter, and the cost of shutting that plant down is tremendous. In a case of that kind, the economics favor putting in something that will let them continue to operate, even though the gas they are going to make in a catalytic plant may cost more than the gas they are using normally.

I can give you a general figure. You can manufacture a 540 Btu gas equivalent to carburetted water gas at a cost of about 60 to 70 cents per 1000 cu ft, depending on the cost of the raw feed, and depending on the size of the plant. In other words, that would be a fairly large plant, where the labor cost is absorbed by a large volume of gas. It would be also based on butane somewhere in the vicinity of 10 to 11 cents a gal. Each cent increase in the cost of butane would add about 5 cents to that holder cost. The above figures do not consider capital changes.

WORLD'S LARGEST OPEN HEARTH IS COMPLETED BY WEIRTON STEEL

▲ THE biggest stationary open hearth furnace in the history of the steel industry has been placed in operation at the plant of the Weirton Steel Co., Weirton, W. Va. The furnace is Weirton's No. 1 which has been rebuilt and enlarged from a former capacity of 200 tons to a new capacity of 550 tons.

Recently, an entirely new open hearth furnace of about the same capacity was tapped for the first time at the plant of Great Lakes Steel Corp., Detroit, Mich., and another division of National Steel Corp., fifth largest steel company in the United States.

The capacity of the new Weirton furnace is more than three times as large as the average capacity of open hearth furnaces currently used in the steel industry. The raw steel produced by this giant furnace in a single heat is equal in weight to the total amount of steel in more than 400 automobiles, and a single heat of the furnace also provides raw steel for enough tin plate to make 3⅓ million No. 2 cans.

The overall dimensions of the new Weirton furnace are: length, 96 ft, 6 in.; width 29 ft, 3 in. at center and 24 ft, 6 in. at the ends; height, 15 ft from the hearth floor to the top of the furnace. The furnace contains more than 1000 tons of steel and refractory materials in varying sizes equivalent to 1,000,000 9-in. bricks. Detailed data are given in accompanying table.

No. 1 OPEN HEARTH FURNACE

550 Ton Capacity

FURNACE PROPER

Bath size: 58 ft, 0 in. long x 18 ft, 6 in. wide x 3 ft, 9 in. deep.

Overall dimensions: 96 ft, 6 in. long x 29 ft, 3 in. at center; 24 ft, 6 in. ends; height floor to top, 15 ft, 0 in.

Span at center: 24 ft, 9 in., 3 ft, 0 in. rise.

Slope of back wall: 45 degrees.

Doors: 7—4 ft, 10 in. x 4 ft, 7 in.

Port ends are basic brick construction.

Slag pockets are basic: 23 ft, 8 in. long x 19 ft. 0 in. wide x 13 ft, 3 in. high.

Fuel: oil and tar.

Tapping: 2—280-ton ladles, 2—400 cu ft cinder pots.

CHECKER CHAMBERS

Cu ft of checkers: 11,300 each.

Checker brick: 12 x 6 x 4, 8 in. x 8 in. opening.

Flue opening: 130 sq ft each.

Chamber opening: 75 sq ft each.

Flat suspended roof.

CONTROL

2—Stacks 80 ft, 0 in. high x 7 ft, 3½ in. diameter.

1—Combustion air fan, 40-hp, 1200-rpm, 30,000 cfm. pressure, 2 in. water gage.

1—Ejecting air fan, 100-hp, 1200-rpm., 30,000 cfm., pressure 2 in. water gage.

1—Stack secondary checkers, 2500 cu ft.

1,000 Tons of steel in furnace and checker chamber.

1,000,000 9-in. brick equivalents in furnace and checker chamber.

Centrifugal Tubular

. . . . centrifugal casting methods can be used in the manufacture of many products . . . . the directional nature of the crystalline structure affords advantages in many applications . . . .

▲ THE centrifugal production of alloys in tubular sections in the last few years has developed to an extent where nearly any section can be quickly produced from most alloys. Whether the alloy can be wrought or does not have hot workable properties makes little difference.

Centrifugal casting procedure has been in use for many years. Some of the earliest trials go back to 1875 when attempts were made to cast locomotive tires. A British patent was granted to Anthony Eckhardt of Soho, Birmingham, in 1809 for centrifugal casting, using removable molds which could be revolved either in the vertical, inclined, or horizontal position. This is very similar to the centrifugal casting procedure in use today.

The process was used to some extent in World War I to produce many types of material. A large production of copper driving bands for shells were centrifugally cast in short lengths in washed chilled molds in 14 and 16 in. diameters. These bands had superior properties and could be hot pressed into place. The wash used on these molds was a silica wash and very similar to the wash used in centrifugal casting as carried on at the present time. Tubes with diameters of 14 and 16 in. are produced today up to 17 ft in length compared to 8 or '0 in. of those days.

Many papers have been written, some giving very detailed procedures of operation, and others the materials produced, while many of the advantages and possibilities have been neglected, particularly the commercial value to industry.

Some of the advantages of the process are that many products can be easily obtained from a centrifugal casting, a few pieces of each of the various sizes can be produced, many not being standard as to shape or size, and there is flexibility in producing small lots of special alloys.

The remarks in this paper refer to the larger centrifugal tubular castings made in a horizontal position with sufficient pressure to produce a solid centrifugal section throughout, without seams, cracks or center shrinkage commonly called by many writers as banding.

Figure 1 — The plate roll shown in the upper half of the figure is made of a 14,000 lb centrifugal casting, 18 in. in diam, material is a 12 per cent chromium alloy. The lower roller is similar to the top except that it is smaller.

Tubes are being manufactured in lengths to approximately 17 ft and in diameters to 20 in. and in shorter lengths to much larger diameters. The largest weight of metal poured in a centrifugal tube by our company up to the present time is 14,000 lb. The weight of metal and size of tubes is only limited at this time by machine size. When the designing and building of a machine of sufficient weight and capacity is completed, it will be possible to produce tubular castings of 25,000 lb or more.

It is important to consider the centrifugal process with the idea that it produces forces with motion on the liquid metal while cooling of approximately 100 times gravity, and continuously supplies liquid metal under pressure for shrinkage purposes until the final shape is formed, and that the last metal to solidify would be in the bore wall, and that it does not have internal shrinkage voids. This may not always be the case and some banding could exist when proper speeds are not controlled throughout the casting process.

We can consider centrifugal casting as a means of breaking up columnar crystallization. When a molten metal or alloy solidifies, it follows columnar crystallization principles closely when only atmospheric pressure and relatively little motion are present. If both pressure and motion are present, each particle of a liquid, whether it is a solid solution or complex alloy, in solidifying, breaks up into two parts, slightly different in composition and also in fusibility. The one part solidifies because it is infusible at the existing temperature and attaches itself to the previously solidified enclosing walls, and the balance is fusible at the existing temperature until more heat is dissipated, and then solidifying under pressure on the walls.

This process of solidification continues with the help of pressure and motion causing the liquid layer to wash over the previously formed solid material, giving up its heat and continuing the process of solidification by diffusion or convection of its heat.

The beneficial effect of centrifugal casting on crystallization gives the centrifugally cast alloys properties to stand both cold and hot working operations. The familiar static cast structure due to condition of casting has been broken up, and a very uniformly fine crystal structure is formed throughout the material

Presented before AISE Annual Spring Conference, Buffalo, N. Y., April 27, 1948

Castings for Industry

By EARL M. ANGER
Chief Metallurgist
The Duraloy Co.
Scottdale, Pa.

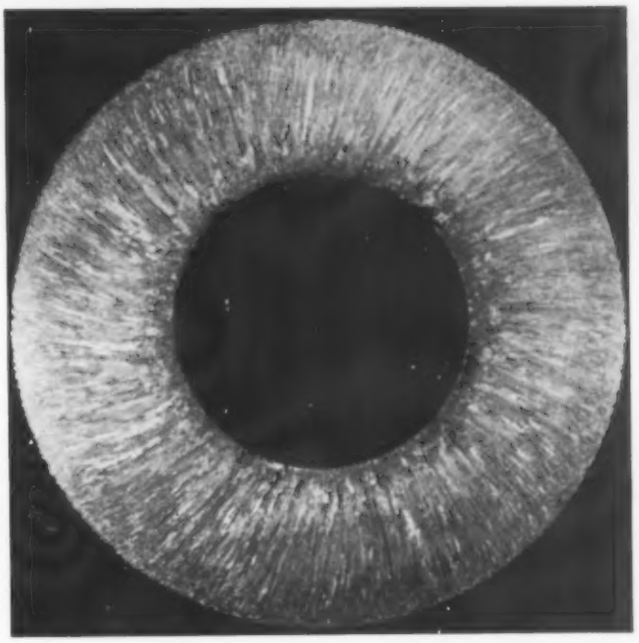


Figure 2 — The crystalline structure of a coarse grain alloy is illustrated in the macro-graph. The section is 14 in. outside diameter as cast, and is composed of about a 12 per cent chromium 0.07 per cent carbon alloy.

compared to that of the static structure of the same alloy.

Centrifugal casting can best be defined as a process by which fluid pressures stimulate solidification and the stimulating effect caused by the centrifugal force is dependent upon the mold speed and the density of the metal.

The forces involved produce pressure on the liquid away from the axis of rotation, and causes a continuous build-up of cooling alloy from the mold wall.

Figure 1 shows in the upper half a 14,000 lb centrifugal tubular casting in the cast condition direct from the mold before cleaning. The size can be visualized by comparison with the 12-in. indicator. This casting has a 4½-in. wall thickness and is fifteen ft in length.

The lower portion of Figure 1 shows a smaller tube which was found after removal from the mold to be mechanically straight and true in diameter. This is also in the cast condition and direct from the mold. These rolls, used after heat-treatment, machining and attaching the trunnions are used in the glass industry. The advantages of these rolls when rolling plate glass are great and they have been adopted as standard after years of trial. It is necessary to hold the glass plate closely to gage and if the rolls wear or buckle in any way, they will quickly cause great loss of product.

Production of bored and turned tube sections 8 to 20 in. outside diameter with three and four in. walls, and approximately 16 ft in length can be produced in high and low alloy chemistry.

This is an example of the latitude that is available to meet approximately any requirement by the use of the centrifugal method of casting. These tubes are free from seams, cracks and shrinkage and must stand hydrostatic tests.

In the case of type 410 tubes which contains 12 per cent chromium, the physical properties after heat treatment of the centrifugal stock are shown in Table I.

These properties are representative of ordinary production taken from material from smaller tube sizes. The material was made to ASTM specification A221-39 Class 6.

It is apparent at once to anyone in need of large sections the many products that can be made from centrifugally produced tubular sections of these sizes. The range of wall thicknesses produced are from a 2 in.

TABLE I

CHROMIUM STEEL CASTINGS — TUBING 5½ X 3 IN. FULL LENGTHS

Heat No.	Analysis									Yield point psi	Tensile strength psi	Elongation per cent	Reduction of area per cent
	C	Mn	P	S	Si	Cr	Ni	Mo	V				
U3-4186	0.12	0.53	0.026	0.022	0.30	12.35	Tr.	....	....	79,900	104,500	23.5	56.8
U3-4187	0.12	0.68	0.019	0.018	0.26	12.35	0.10	....	....	80,800	103,000	22.0	62.1
U3-4190	0.13	0.63	0.019	0.015	0.50	12.45	0.08	....	....	83,200	112,000	21.5	50.8
U3-4191	0.13	0.70	0.028	0.020	0.50	12.55	Tr.	....	....	82,800	108,800	20.0	50.0
U3-4193	0.11	0.74	0.028	0.024	0.40	12.05	Tr.	....	....	79,700	105,800	23.0	58.6
U3-4195	0.11	0.66	0.020	0.019	0.27	11.85	0.08	....	....	74,200	98,500	25.0	62.3
U3-4196	0.11	0.61	0.027	0.021	0.30	11.75	Tr.	....	....	77,200	99,100	23.5	63.5
U3-4197	0.10	0.63	0.025	0.018	0.55	12.05	0.07	....	....	81,500	103,800	20.5	56.2
U3-4198	0.10	0.62	0.019	0.022	0.49	12.15	Tr.	....	....	80,700	103,900	22.5	60.1
U3-4199	0.12	0.53	0.017	0.017	0.32	12.05	Tr.	....	....	72,300	90,600	26.0	66.1
Required	....	....	....	....	....	....	....	....	....	50,000	80,000	20.%	30.%

outside diameter with ¼ in. wall to 32 in. outside diameter with 1¼ in. wall or thicker.

The process of centrifugal casting as carried on by our company for making large tubes for many years is somewhat similar to the centrifugal process for the cast iron pipe industry. The steel and high alloy compositions are melted in both basic and acid lined arc furnaces and in basic induction furnaces. In the manufacture of some forty alloys for producing tubes it was found that varied furnace equipment is necessary to completely cope with the customers various requirements.

The lining of the centrifugal molds with the refractory sand mixture is a well developed procedure and extreme care must be taken to satisfactorily ram a large tube mold that will hold to dimensions and have a true circle in a length of sixteen feet. The mold must also stand the mechanical operation of centrifugal casting.

The lining material is a composition of the highest grade silica sand, fireclay, core binders and water. The ramming material is mechanically mixed and the physical properties of the lining material are controlled to specification for the various requirements of the centrifugal tube manufacture. The lining mixture is rammed around a form in a cast iron casing to form the mold for casting the tubes. The lining thickness may run from one to four in., depending on the size of the tube required and the size of the casing being used.

The hardness of the rammed mold will run around 90 and will have a dry compression strength of 250 psi after processing at 450 F. The mold casing is fitted with head plates which must be securely fastened and remain in place while the pouring and spinning operation is carried on. The metal is poured through a runner box with a nozzle leading into the spinning mold. The molds are rotated until the tube temperature has dropped low enough to allow the machine to be shut down without injury to the tube casting. This may take from a few seconds with a light wall tube to an hour or more with heavy walls and in ratio to the quantity of metal poured.

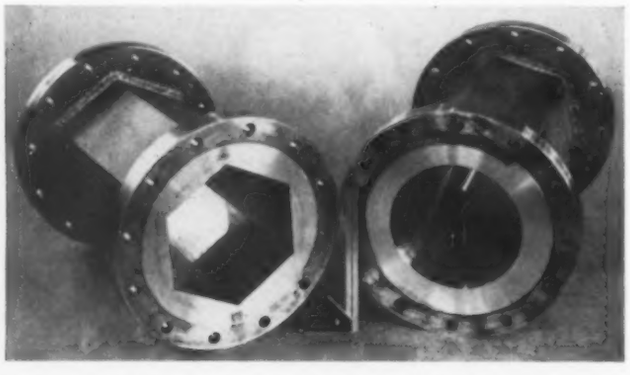


Figure 3 — The sections produced by the centrifugal casting method need not be circular as is illustrated by this photograph of stainless steel columns.

Figure 4 — Valve ball checks made by the centrifugal casting method are shown in the diagram.

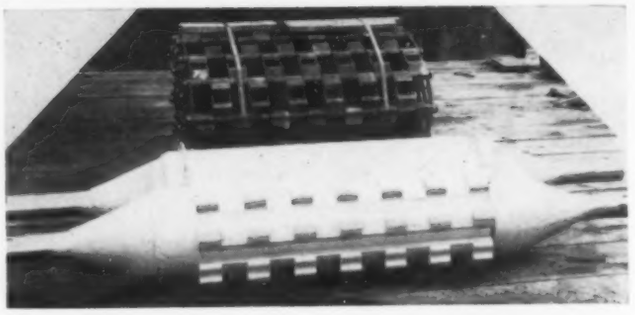


Figure 5 — The fluted drive rolls illustrated were made for a heat treating chain assembly.

Figure 2 shows the type of structure obtained, showing the effect of centrifugal force on a coarse grain alloy. The familiar curve of the crystals shows the direction of rotation. The crystals also protrude continuously from the outside to the bore of the tubular section. The crystal structure around the bore shows the crystals were produced with sufficient centrifugal force to eliminate the usual static structure, and forced the slag, inclusions and any gas to the bore which can be removed in the boring operation.

It has been proven that good hot and cold rolling properties are obtained when the structure consists fully of this type of grain. This will not be the case when static casting structure is present, and good results can only be accomplished with properly produced centrifugal structure.

Requirements for centrifugal casting of special shapes have also progressed considerably in the last few years. The process is used for the production of conveyor screws with excellent results. The metal in the flights are solid and of excellent physical properties. The shrinkage problem of this type of casting is very serious when made statically, and when made centrifugally the shrinkage is taken care of efficiently with fluid metal under the pressure developed by the centrifugal force.

The production of triangular, square, hexagon, octagon shaped outer walled shapes, and fluted and tapered sections can be commercially accomplished. These sections give a source of material for an endless number of products which can be produced with less labor and less loss of stock material.

An example is shown in Figure 3. All parts making up these assemblies were made centrifugally. The hexagonal exterior surface is made to coincide with the final machined column as shown on the right. The final hexagon interior is machined from the bored tube. The fabrication of this assembly was considered impossible, until it was found it could be made centrifugally, and since that time many have been made satisfactorily with saving of both labor and material.

Figure 4 shows tar valve ball checks which were machined from centrifugally cast tubular sections and made in 12 per cent chromium alloy. They are free from defects such as shrinkage and other flaws.

The tubular section in this case is turned and bored

after the necessary heat treatment. The next operation is to cut a half round shape into the tube wall and then cut off the rough turned valve ball check blank. They are then inspected and any center shrinkage is plainly open to view or non-destructive testing will at once identify any defects. These blanks are then placed on an arbor and spherically finished to less than 0.001 variation in diameter.

The question has been asked many times, can a tube with a standard wall thickness be centrifugally cast that will stand the regular tests applied to pipe in industry? The answer is "yes." We have completed a 12 in. pipe order calling for 12 per cent chromium for oil refinery requirements. The tubes were hydrostatically tested at 1000 psi pressure and the other required tests were very satisfactorily accomplished.

This customer required an eight ft radius, fifteen ft length of 12 in. pipe to complete the 12 per cent chromium steel pipe line. This section was hot bent to shape without any trouble.

Figure 5 shows a fluted drive roll into which circumferential grooves have been cut to form the drive teeth to mesh into the load chain also shown on the figure. The flutes are centrifugally cast with the tube and they can be rounded, square or triangular as desired. The assembly shown is used in a heat treating operation in various plants requiring conveying equipment working under heavy loads at high temperature.

Centrifugal cast rolls are being used in abrasive paper industry for the back up rolls on which the abrasive paper is cut to width. These rolls have proven their superiority over the other rolls in service and centrifugally produced rolls are fast taking their place in the industry.

There are many theories advanced as to the reason for the superior abrasive resisting properties. The crystals seen when the section is etched show the working surface of the roll is made up of crystals on end, and this seems to be the most logical theory advanced for the superior abrasive properties. The actual hardness determination in any of the cases seems to be about the same, namely 62-65 Rockwell C.

Figure 6 — The corrosion resisting alloy cartridge shown is used in the chemical industries and is an assembly of centrifugally cast parts.

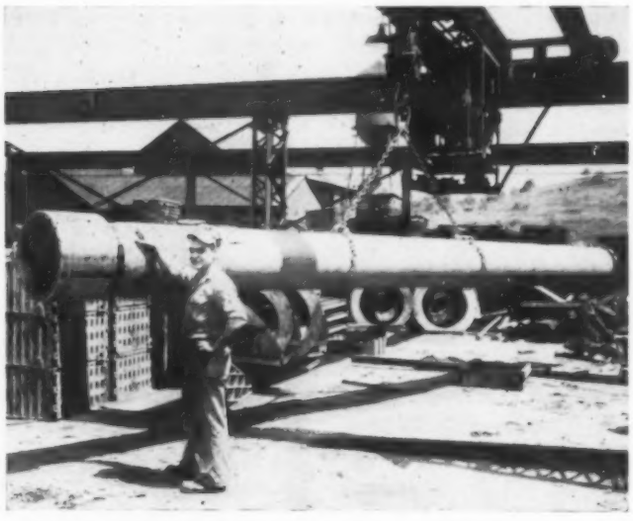


Figure 7 — The rolls shown were centrifugally cast for a conveyor.

Figure 8 — Centrifugally cast tubes have been found effective in resisting the effect of flame impingement and hot-gaseous atmospheres in radiant heat applications.

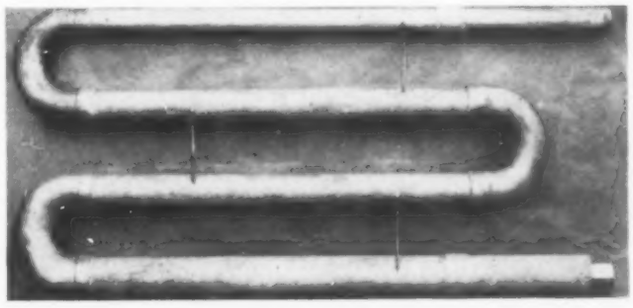


Figure 6 shows a cartridge used in the chemical industry and is an assembly of centrifugally cast parts. These cartridges are made in corrosion resisting alloys, such as type 304- 18 per cent chromium—8 per cent nickel; type 310- 25 per cent chromium—20 per cent nickel.

The conveyor rolls shown on Figure 7 are centrifugal cast tubes with trunnions welded in place. These rolls are lehr rolls used in the glass industry for annealing glass plate. The life of these rolls under operating conditions will be five to ten years.

Several of the super alloys have been produced in pipe sizes with standard wall thickness from centrifugally produced tubular blank sections. In the production of these tubes hammering or rolling from the ingot stage was not necessary to produce pipe sizes of excellent quality. Full mill lengths tested satisfactorily the same as the regular mill run of tubes.

A process of producing sheet from some of the more difficult alloys, while still in its infancy has shown some amazing results. Centrifugally cast tubes were partially slit longitudinally on opposite sides and rolled as a double. The sheets after parting were cleaned the same as in ordinary sheet procedure, and rolled directly into sheets without any trouble. The quality of the sheets was good.

The radiant heat application in heat treating furnaces in industry has required a radiant tube which will stand the effect of flame impingement and hot

gaseous atmospheres on the inside of the assemblies and the various gas compositions of the furnace atmosphere on the outide. The centrifugally produced tube assemblies have been very successful in this application and is now standard equipment. Figure 8 shows one of these completed units suitable for line assembly.

In World War II centrifugal cast tubes or retorts contributed in a large way to the successful production of magnesium. The process required tubes to operate at 2150 F, and the life of the centrifugal tubes was the chief reason that the process was successful.

It is interesting to relate that many retorts after a long production run could be returned to service by blowing them up with air pressure, thus returning them to the original shape. The vacuum had a tendency to pull in the retort walls at the 2150 F temperature, and the intermittent pressure treatment was practiced to a large extent to return the retort to shape.

DISCUSSION

PRESENTED BY

R. K. GLASS, Assistant Chief Metallurgist, Republic Steel Corp., Donner Plant, Buffalo, N. Y.

E. M. ANGER, Chief Metallurgist, The Duraloy Company, Scottdale, Pa.

A. G. ERICSON, Chief Engineer, Homestead Works, Carnegie-Illinois Steel Corp., Munhall, Pa.

R. K. Glass: I am sure Mr. Anger's paper brought to the attention of all those present the many advantages of centrifugal casting, not only in tubular products but in irregular shaped products. Centrifugal casting is not a recent development. The steel casting industry has been working on various types of centrifugal casting for railroad equipment, car wheels, and the Ford Motor Co. has made very great strides in the production of gears and other castings which were formerly forged. The fact of the matter was that several years ago the forging industry became very much alarmed at the large improvement in the uniformity of grain flow, which was made possible through centrifugal casting especially of gears.

Colonel Dickson of Watertown Arsenal presented a paper about 1930 on the advantages of centrifugal casting gun tubes, especially with monel metal tube liners. The advantage was they controlled, as Mr. Anger says, the directional solidification, that is, at right angles to the build up of the metal from the center.

I would like to ask Mr. Anger if he has made any large gears in nickel steels running from two to five per cent?

E. M. Anger: We have not made any gear stock. We have made SAE 3312 which contains 2¾ per cent nickel in tubular stock.

We would not expect trouble if the two to five per cent nickel steel were used for centrifugally cast products.

I would suggest if it is a ring gear, that it be machined from horizontal centrifugally cast six ft tube, which has been bored and turned and cut into sections sufficient for one gear. Then you can machine the blank on a gear cutter in the usual way. This would make, after heat treatment, an excellent gear. If the gear has spokes, it could not be made by this process, and only a semi-centrifugal product would be produced; because much lower speeds are used when casting in the vertical position.

This brings out another disadvantage, as speed is the determining factor in grain size; and the vertically centrifugally cast products are not produced with the higher speeds that we use for horizontal tubes. Tubular sections, when semi-centrifugally cast in sand molds at much lower speeds, have not the fine crystal structure that you have in the horizontally produced tubular sections.

If a suitable section could be made from horizontally cast tubes, I think the machined product would have as good or better physical properties than from forged products. The vertical centrifugal casting process can do a better job than static casting, and the product from the horizontal process is an improvement on the vertically cast product.

R. K. Glass: Inasmuch as you are producing grain flow from the inside to the outer at right angles from the center—grain flow from the inside to the center—would there be any advantages in making large mill drive pinions by upsetting the tubular product and then cutting the gear tooth? You would have the grain flow from the base of the root of the gear tooth, then upsetting to the diameter of the tooth, therefore any banding in the tooth section would be horizontal with the grain flow and not crosswise with the grain flow which often results from a straight forging?

E. M. Anger: I think that is answered well in the rolls that we make for the abrasive paper industry. When using these rolls, they found that when cutting the abrasive paper on the face of the roll with circular knives, that the wear resisting properties of the alloy itself and its effective non-galling properties present a combination which has proven very beneficial over all other roll materials.

For that reason, I would say that a gear when made by this process will be an improvement, as you are working on the end of the grain on the face of the teeth and the bending motion would be opposite to what it would be the other way, and you would have a gear with different properties from a cast or a gear cut from wrought stock.

R. K. Glass: Do you have any comparison of physical properties in the centrifugal cast tubing, such as the difference between horizontal and cross section tensile bars?

E. M. Anger: We have some results on a 15 per cent chromium pipe. We did considerable work in war time along this line. They were made for bearing stock where high speeds were used, and this required non-galling properties to a large extent. This alloy contained, as I said, about 15 per cent chromium and close to 0.250 per cent sulphur with 0.50 per cent molybdenum. After the alloy was heat treated, it came close to 95,000 psi for the tensile strength on the vertical test bar—with a 45,000 psi yield strength, and on the horizontal test bar running along the section we had close to 130,000 psi tensile strength. That is, the tensile

strength and the other properties are greater horizontally than they are around the circumference.

R. K. Glass: In concluding, over the past twenty-five years I have had occasion to make tests and work on centrifugal castings, and I believe for the steel industry there are possible improvements that could be made and worked out on mill drives, spindles and several other parts, especially pinion gears. For large pinion gears, around 20 in. in diameter, it is difficult for some plants to obtain an ingot with at least 5 to 1 reduction, and a great many of the failures are due to the grain flow being in the direction of the rolling which would be parallel to the direction of the gear tooth. We have had failures in gear pinions, especially when overloaded, due to insufficient reduction and transverse grain flow.

A. G. Ericson: I was wondering how centrifugal castings present themselves as blow tubes or blow pipes for blast furnace use. Recently we had some failures on our blow pipes, and perhaps blow pipes could be made from heat resistant iron, centrifugally cast for greater strength and density, instead of cupola iron statically cast.

E. M. Anger: As far as the imperfections in blast furnace blow pipes, we are supplying similar material for the burners in glass furnaces. It is the same principle. We supply these heat resisting castings for this industry.

I think if the proper alloy were used for the blow pipes and if a centrifugal tubular casting is used, a superior blow pipe would be produced for this requirement. The heat resistant alloy can be 24 per cent Cr and 12 per cent Ni alloy. It would be different from the regular wrought type 309 specification for this heat resisting alloy. We have compared it with other alloys and it stands up under the temperatures required right at the edge of the burner. This is due to the high hot strength at high temperature which will run 30,000 psi when tested at 1600 F.

Member: I wanted to ask Mr. Anger have they made any attempts to make the thick-walled tubing which would be involved if you were going to make a pinion?

E. M. Anger: We are making tubing by using chilled molds. The question of banding is important. You cannot produce centrifugal castings and not control the process by using slow speed starting from the outside and a higher speed to get the center. You cannot eliminate banding unless it is done. We have worked that out and there is no banding. We have made in wartime 15 per cent chrome with the outside diameter 18 in. and the bore 7¼ in. We had no banding. That is what the control of the speed will do. I think that can be easily worked out. We consider banding a definite defect and it has been eliminated. We have special casings for these large 12 per cent chrome rolls which are 16 in. outside diameter by 4 in. bore. The rolls have been cut in sections and macro-etched and they show no banding. The banding, as I said, is eliminated by the control of the speed and it has to be controlled from the start. It is the only way you can control thick wall tubular products. Usually in making thin walled tubes if the speed is below requirement, the chill from the mold is enough to stop banding. In the paper I mentioned mostly sand mold production, in fact the larger portion of our production is made with chilled molds. We did cast during the war guns on the same principle as used at Watertown. We made many gun tubes with a cast one in. bore. We macro-etched the breech section which was 12¾ in. outside diameter with a 1 in. inside diameter, and we did not have banding at that time. That was controlled. I might give you the speeds used. The metal was metered and timed at 3¾ minutes for 2580 lb to go into the chilled mold. The mold weighed 14,500 lb machined. The chill ratio ran from 2.8 to 5.2 to 1 along the 12 ft length. You can realize the amount of chill we had. It took 3¾ minutes to run in and the speed was changed from the 750 rpm starting in the 3¾ minutes, up to 1250 rpm. That was the only way the banding could be eliminated.

R. K. Glass: I wonder if Mr. Anger could define banding now, and if he will explain the composition and the difference for some of us might think of it as microscopic banding.

E. M. Anger: The microscopic banding, of course, is banding that can be seen in the annealed sections after micro-etching and sometimes the microscope is necessary to reveal the variations. You have crystals of various sizes running in circumferential bands throughout the section. That is what is meant by banding in centrifugal casting as mentioned in the paper. Excessive speeds sometimes are the cause of bands and results in a difference in speed from the first metal chilled on the mold wall and as the fluid metal picks up speed. If the speed is not brought up so that it is all in movement and at the same speed, the solidified metal on the mold wall will be traveling at a higher speed than the liquid metal, then you will get a line running circumferentially around in the tube wall. We blame it completely to shrinkage caused by not supplying the metal at the right time and uniformally building up the crystalline structure of the metal on the mold wall to the bore of the tube. That is what I believe is the best definition of banding in centrifugal tubing. Chemical analysis reveals no segregation in bands, and microscopic examination reveals crystal size differences with microscopic shrinkage.

Member: I would like to ask Mr. Anger what process is used in cooling, when casting a tube about 8 or 10 in. diameter, about 6 ft long and 2 in. wall.

E. M. Anger: The treatment after removing from a chilled mold depends on the composition. We found when making SAE 3312 nickel steel tubes, that as soon as we saw the shrinkage had taken place by looking in the end of the tube and the temperature had fallen to about 2300 F, there is a region where SAE 3312 tubes, while passing through this region, are tender and spinning speed must be reduced and the tube removed from the chilled mold at 1800-2000 F and covered with ashes or like material to continue cooling to room temperature.

When making tubes, namely, 1020 or similar specification, the tube when about 1200 to 1400 F is removed from the chilled mold and allowed to cool in air.

It would be hard to give a general routine for removing tubes as both the structure and composition affect the required treatment after removing from the molds. Some alloys require immediate heat treatment without allowing the product to come to room temperature.

Factors Affecting Open Hearth Production

. . . . maximum open hearth production will be promoted by proper chemical balance, by properly scheduling additions, and by taking into account the physical factors such as shape and surface area of charge . . . .

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▲ THE open hearth production problem is a two-phase situation. A very prime and important thing is to get the material that you are going to make steel out of into the furnace. The faster you get it in, the quicker you can get it out. This is primarily a question of organization and equipment and does not affect the topic of the effect of hot metal on open hearth production. The other phase which is equally important, and sometimes even more so, is the chemical and the physical nature of the charge. Now, to simplify this subject, this paper will be made general for if all the chemical factors that are involved were discussed it would never be finished.

Primarily, once a furnace is charged the object is to get as much oxygen into the furnace as the oxidizable elements need. Now, the oxidizable elements, also called reducing elements or reducing agents, consist chiefly, but not wholly, of carbon and silicon. Other elements which can be considered reducing agents contained in both scrap and pig iron are manganese and phosphorus. However, insofar as open hearth speed is concerned, and insofar as open hearth quality is concerned, they exert a minor factor when other items are balanced. To make it clear how important these things are, swings in open hearth time of six to seven hours on spring heats, due entirely to an unbalance of the charge are not uncommon. The effect of open hearth speed on soft heats is not nearly so great because there are different techniques in making them, because, in the past at least, when one could get the kind of scrap that was wanted, they were charged somewhat differently. Swings in soft steel occupy time as much as two hours due to chemical unbalance in the charge itself.

The chemical factors involved in the open hearth charge are therefore very important. This is not something that is theoretically abstract, or impossible, something that means dollars and cents.

Combined with the chemical nature of the charge, which consists of hot metal and scrap and limestone, the physical nature of the charge is also important. Furthermore, the mechanical features of production, which involves the speed of charging, also interact upon the chemistry of the charge. Sometimes a very poor chemical unbalance, such as too high a silicon in the charge, is more or less overcome by a delay in charging scrap, or a delay in receiving hot metal. In other words, the interaction between the mechanical features of open hearth speed and chemical speed—and factors having to do with the chemical makeup of the charge do interact on one another. They can sometimes interact favorably when one is out of bounds, and sometimes act most unfavorably.

Suppose that in making a heat of open hearth steel, scrap is charged promptly, there are no delays, the scrap is of good size. Suppose the pig iron is on time, when the heat is ready for it, as the first helper would say. But suppose the chemical nature of the charge and the pig iron, or both, are so high in silicon that the oxygen coming in with the fuel during the melt down is insufficient to oxidize out all the silicon and a good portion of the carbon too. In that case, there is a lot of carbon residual in the bath, and the heat is said to have "melted high." In order to get the carbon down it is necessary therefore to come in through the doors with a number of pans of ore. The removal of the carbon if the heat melts very high sometimes consumes extraordinary periods of time.

A second result of such a situation is that the type of charge feed ores available today are high in silica, which poisons the slag, produces a physical and chemical nature in the slag, such that refining time is greatly slowed up after the first initial interaction of the ore. The final slag is of poor shape and consistency. The lime is said to be hard, although the lime had nothing to do with it. The heat takes a long time to make, therefore, and is of very poor quality after you tap it.

On the other hand, suppose again the scrap is on time, and suppose that the hot metal is delivered promptly, and suppose that there is an insufficient amount of silicon in the charge. With a pretty constant fuel input, there is more than sufficient oxygen coming in from the fuel, which results in the oxidation of all the silicon and most of the carbon below that carbon content which is desired in the final steel. It is then necessary to come into the furnace with a charge of cold iron and bring it back, or additional hot metal, which is time consuming. In other words, the time of refining is extended because the charge is melted soft. The time lost in such an operation, when the heat melts soft, is seldom as serious as when it melts very hard.

These are very simple illustrations of what is meant by saying that a heat has to be charged in such a fashion that the incoming oxygen balances the amount of reducing agents in the charge. This of course varies with each type of heat that is to be made, but without too much effort, a heat can be charged in such fashion with a half way decent flame control, so it will melt with a

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pan or so of ore. When a heat melts requiring but a pan or so of ore, it is one which takes a minimum of time to make. If a heat melts hard, that it requires a lot of feed ore, it takes a long time to make the heat. Or if the opposite is so, if the heat melts in such a fashion as to melt soft, and therefore requires a drink of hot metal or an addition of cold iron, again it takes a longer time to make a heat. The minimum open hearth time is accomplished when the heat melts with minimum adjustments.

If the charge of scrap is such as to present a lot of surface per unit of weight, then the amount of scale, or oxygen trapped from the atmosphere, is such that larger quantities of reducing agents, that is carbon and silicon, will be oxidized out than otherwise would be the case. Large pieces of heavy scrap present less surface to be oxidized by the flame than bundled scrap or a lot of light scrap. The heat will then melt harder or higher in carbon even though the chemical factors are all right than in the case where the scrap is light. As a consequence, for very careful chemical balance there has to be considered the amount of reducing agent in both the scrap and hot metal that is to be charged into the furnace, and due consideration should be given to the kind of scrap to be used. Thus, a heat that is charged where, for example, the total silicon charge is 50 points, and where 45 per cent is hot metal, if the balance of the scrap is composed of about 50 per cent bundles and 50 per cent heavy, this might be just right to melt on the button and give a heat of minimum time.

On the other hand, if one should neglect to use 50 per cent of the scrap as heavy scrap and use all bundles, the heat will melt soft, too low in carbon, and it will require more time than otherwise would have been the case. Or, if the bundles were not used and all heavy scrap were charged, the heat would have melted hard and would have much higher carbon than otherwise would have been the case, ore would have to be added and more time will be consumed than if things were just right. That is why both the chemical nature of the charge, which involves the hot metal and the scrap, and the physical nature of the scrap must be considered in order to produce a correct chemical balance in the charge. The amount of oxygen input must balance chemically the reducing agent input.

Now, obviously it is perfectly understandable why heat, otherwise being correct in chemical balance, but which has a delay in hot metal, will cause the heat to melt soft, because the scrap is under fire longer, it picks up more scale or oxygen, and therefore exists as a greater reservoir to reduce the carbon and silicon in the incoming hot metal.

If a heat is charged properly, its time can be predicted with skilled help, as well as its quality. Insofar as furnace techniques are concerned with quality, the blast furnace operator could say the same thing. If he could get the kind of charge he wants right on time he could just about predict what will be obtained within a pretty narrow range.

Now, in the past there has been a lot of argument in open hearth practice whether there should be high residual manganese or low residual manganese carried through the heat in order to get quality. It is my considered opinion that manganese residual has nothing to do with open hearth quality at all, but a heat is good or poor because of other factors which cause the manganese to be low or high. A very easy way to determine for each grade of steel the quality of a heat in a furnace before it is tapped is to run an iron oxide in the finished slag. There is nothing mysterious about iron oxide, and nothing holy about it either. It is a simple chemical determination which actually tells, if one wishes to know the relationship, what the amount of lime and silica is in the slag, and that is what is desired.

How basic is the slag? The chemist can analyze for lime and silica, but it is a costly and time consuming analysis for us on each heat. A simpler way to do it is simply run iron oxide. With a little experience, the operator knows pretty well, with a given type of practice, what iron oxide produces the best steel. It is also the iron oxide in the slag which produces the cheapest ingots in the fastest open hearth time. There is probably no more vicious poison in an open hearth heat than too much silicon, which results in too much silica in the slag. The silica in the slag does not have to come from the pig iron to be poisonous, it can come from feed ores, or sand, or dirt that is sometimes wrapped in the bundles. Any source of silica, such as dripping roof, that gets in the slag and which exceeds certain ratios of lime to silica is a vicious poison. Introduction of silica in the slag by such methods whether from sources of SiO_2 itself, rather than silicon in the iron itself slows up open hearth time because as the silica advances in percentage in the open hearth slag, the ability of that slag to refine and oxidize decreases in speed and open hearth time again is increased and quality is grossly decreased. A very simple illustration of the effect of inordinate amounts of silicon in the pig iron or inordinate quantities from the scrap or inordinate inputs of SiO_2 from other sources is the question of phosphorus. As the silica in the slag advances, the ability of the slag to hold phosphorus decreases, and very small changes in the acidity or the silica content of the slag, results in very heavy changes in the phosphorus in the steel in the ladle.

To reiterate, among the reducing agents the most important element in hot metal which affects open hearth production is silicon. Other impurities in hot metal also affect production to some degree in a roundabout fashion. Suppose the hot metal is running high in sulphur and it may be necessary in order to produce given grades of steel, to increase the lime charge. Lime charges in an open hearth furnace in excess of 23 per cent limestone equivalent, have been used, which were of course burnt lime. In this case, the operators were fighting sulphur. The sulphur did not arise from the hot metal, but came from the fuel oil and the fact that there was so much very light scrap that in charging the furnace it was piled nearly to the roof of the furnace so that the sulphur was absorbed from the fuel oil which contained around one per cent sulphur. In order to eliminate sulphur about a 23 per cent equivalent limestone charge was used, which added about 4 hours to each heat than otherwise would have been the case.

If the hot metal is high in sulphur for some reason or other and a grade of steel that is sufficiently low in sulphur to be acceptable for many purposes is to be produced, lime charge in the open hearth furnace must be increased and that means time. Thus high sulphur

pig iron will increase the time to make a heat if certain quality factors are to be observed. Various furnace operators prefer one phosphorus and some other. In some plants phosphorus in basic iron is not accepted over about 0.22 per cent. That is somewhat foolish, as phosphorus per se acts somewhat like silicon in reducing the speed of the furnace because it has to be oxidized, but it is such a minor thing it can be practically ignored, for the swings in silicon are of much greater importance. If a very low phosphorus iron is available then the lime charge in the furnace can be reduced, and because of the fact that the operator does not have to melt so much lime and make so much slag, and thus open hearth time would be decreased.

In conclusion, the control of the elements alluded to herein in their proper balance are the determining chemical factors which have to do with open hearth speed, production and quality.

DISCUSSION

PRESENTED BY

D. NEWKIRK, Manager of Coke Ovens and Blast Furnaces, Ford Motor Co., Dearborn, Mich.

HARRY W. CLARK, Metallurgical Engineer, Ford Motor Co., Dearborn, Mich.

C. L. ALTENBERGER, Research Engineer, Great Lakes Steel Corp., Ecorse, Mich.

H. E. PHELPS, Electric Furnace Superintendent, Rotary Electric Steel Co., Detroit, Mich.

J. A. CLAUSS, Vice President in Charge of Engineering, Great Lakes Steel Corp., Ecorse, Mich.

W. J. REILLY, Assistant Manager Steel Operations, Steel Div., Ford Motor Co., River Rouge, Dearborn, Mich.

D. Newkirk: Some of you wonder which is the worse, the pig iron, the molten iron, or the scrap. I certainly can tell you molten iron is not much good. I started to make it at Ford about 30 years ago, and I have been slipping ever since. I know a little less about it today than I did yesterday. We do the best we can. We take some red dirt that has a lot of sand and clay in it, we dump it in the furnace top with coke and limestone, and hit it with about 20 6-in. guns. The temperature is 1200 F. Out of that seething cauldron comes gas, pig iron and slag; and they contain whatever you put in the top; and, as the paper mentioned, all the elements in the periodic table are involved.

One time when I was looking at a salamander, I saw bright, brassy crystals, and I picked a few of them up and gave them to the chemist. He told me that they were cyano nitride of titanium. I was in Germany one time and saw them tapping cyanides out of the bosh. With that sort of chemistry going on, I gave up years ago in determining what is going on inside a blast furnace. Of course, as the steel paper told you, silicon probably is the predominating element, and that is the one we watch. We control it by the temperature of the hearth. The matter of the ratio of burden to the coke, the temperature of the blast, and the observation of slag temperatures guide the operators.

Harry W. Clark: I would like to ask who determines or predetermines the charge that goes into the furnace and the amount of scrap and iron necessary? Also, who determines the amount of limestone necessary to offset the silicon that you have in the iron?

C. L. Altenberger: You cannot calculate these quantities. The charge for optimum operation will vary from plant to plant quite extensively and also from furnace to furnace. Plant and furnaces must be studied and the basic data must be obtained from experience.

In partial explanation some furnaces habitually melt higher than others; some have more than ample checker work, others are lacking, some have more restrictions to gas flow than others, i.e., some are better designed than others. The type of fuels has a bearing on the problem. As a consequence, charges act differently in a chemical manner. With experienced men, the basic data can easily be established from practice.

Harold Phelps: Would Mr. Altenberger care to elaborate on what he said about measuring the basicity by the FeO?

C. L. Altenberger: We do not have the same situation in the open hearth that you have in the electric. The metal is more or less at equilibrium with the bottom, and the slag with the atmosphere. Our atmosphere is always distinctly oxidizing where your atmosphere is not. Therefore, we always have an excessive amount of oxygen over the bath. So, some of that oxygen goes in the slag as iron oxides which consists of FeO and Fe_2O_3. The amount of iron oxides in the slag is based exactly upon the amount of uncombined lime in the slag. The iron oxide being held rather loosely as a kind of calcium ferrite. If the silica in the slag is high, a lot of the lime is tightly combined and is not available to hold iron oxide. You can figure this out theoretically, or you can go into a furnace—any open hearth furnace in the country—and establish it by plotting the lime-silica ratio against FeO and get a curve with very little scatter in it. Now, you have got to do that with various carbons, the higher the carbon the less the FeO at a given basicity. Having established this, it becomes necessary to analyze for total Fe only and multiply that figure by 1.41 which gives us very closely the sum of FeO plus Fe_2O_3. Total iron is a very quick determination. Knowing the total iron, we know what the lime-silica ratio is, and we now know the FeO in the open hearth slag is very nearly equal, or rather the actual iron content as analyzed is very equal to FeO, as such.

That is also a statement that I made that should be clarified and should not be taken as 100 per cent correct. If you were operating with a high phosphorus iron, such as you do in the southern furnaces where they will carry iron up to a 0.9 per cent phosphorus, phosphorus in the slag acts a good deal like SiO_2. So, if you keep the silica low you can plot the lime phosphoric oxides ratio against FeO and get correlation. It is not quite the same ratio, you get the same correlation. What you would have to do in a furnace like that is plot the lime divided by silica plus a factor times phosphorus. In our practice our phosphorus and iron is relatively low compared with such an operation, and we just neglect the phosphorus.

A MODERN ROD MILL FOR ROLLING STAINLESS STEELS

By EDWARD T. PETERSON, LEWIS W. KING and EDWARD C. PETERSON
Birdsboro Steel Foundry and Machine Co.
Birdsboro, Pa.

. . . . this mill embodies the latest developments in rod mill design . . . .

▲ UNTIL recently it has been generally assumed, by those concerned with the rolling of stainless and other high alloy content rods, that the problems peculiar to this type of product made it impractical to mechanize the alloy mills for high production and low cost.

These problems are: (1) lack of large tonnage orders, (2) variation in required rolling technique for a multitude of different analyses, and (3) extreme susceptibility of many grades to damage by scratching, twisting, stretching, splitting of ends, and checking.

While the carbon steel rod mills have gained tonnage by using continuous mills with multiple stranding and high finishing speeds, the alloy mills have continued, with few exceptions, to meet their special requirements with variations of the original types of hand mills.

It is appropriate at this point to discuss a few representative mills rolling high alloy content rods.

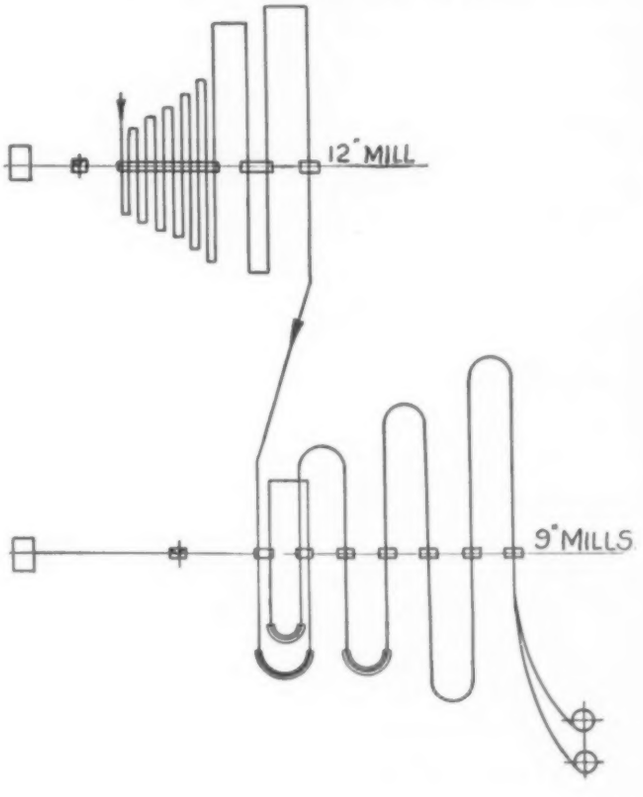
Figure 1 shows the rod mill layout at Rustless Division of Armco Steel Corp., prior to 1948. This was a typical Belgian mill with additional roughing stands. This basic type of mill had the well-known disadvantage of low finishing speed and long loops, with correspondingly limited production and coil size. The mill had only two drives, making it impossible to suit the speed of rolling to the size of bar being rolled, since there were only two different speeds available at any one time for the entire rolling process, and each drive could only be set at the best average speed, considering all the passes which had to be taken on it.

Figure 2 shows a mill with an intermediate train added to take some passes off the roughing train, thus speeding up the roughing operation. The number of drives is increased to three.

In Figure 3, a further refinement of the basic Belgian mill has been made, by having not only an intermediate rougher, but also a separately driven finishing train of two stands and reduced size, thus permitting faster finishing and minimizing length of loop in the small cross-sections. Four individual drives are used.

In Figure 4, the finishing mill is also driven by separate drives, and the intermediate mill has been expanded to take some work off the finishing train, where

Figure 1 — The layout of the old rod mill at the Rustless Division of the Armco Steel Corp. is given here.



Presented before AISE Annual Spring Conference, Baltimore, Md., May 2, 1949

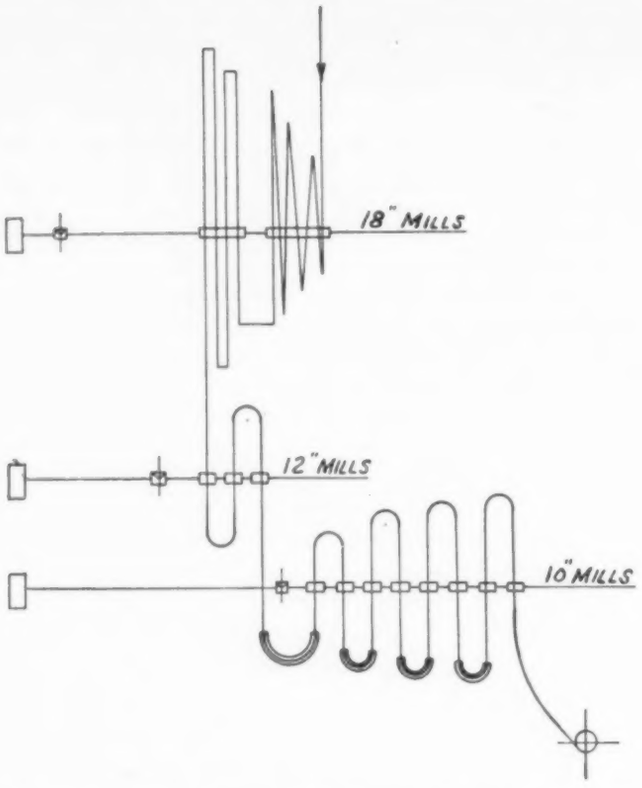


Figure 2 — In this layout, an intermediate train was added to take some of the passes from the roughing train.

sections are small, and long loops are especially detrimental because of rapid cooling.

Figure 5 shows a relatively modern mill in which semi-continuous roughing and mechanical handling appear. The 16 in. intermediate train on this mill is completely mechanized with tilting table and transfers, and five individual drives are used.

In Figure 6 is shown a very advanced layout, in which the finishing mills have only two stands to a drive, and the mill has six drives. Loop length is minimized, and delivery speed is relatively high, with correspondingly increased tonnage and larger coil.

The mills discussed above show a gradual refinement of the Belgian mill, by adding intermediate mills and breaking up the finishing mills into two or more trains, individually driven. However, none of these mills had continuous rolling; none had mechanized roughing, except the one shown in Figure 5, or used mechanical devices to manipulate between mills; none used repeaters on an oval section, or repeated larger than a ⅞ in. square.

Table I gives pertinent data concerning average conditions of operation attainable with mill arrangements as shown above. This chart shows, for the minimum section rolled, billet size, minimum section, coil weight, number of passes, finishing speed in fpm, crew, and production in tons per hour.

It was the objective of the management at Rustless Division to: (1) improve quality by minimizing temperature drop during rolling, (2) reduce conditioning costs by rolling from a larger billet, (3) reduce wire drawing costs by rolling a smaller size rod than was currently being produced, (4) reduce wire mill costs and rod mill costs, and increase yield, by rolling a heavier coil than was currently being produced, (5)

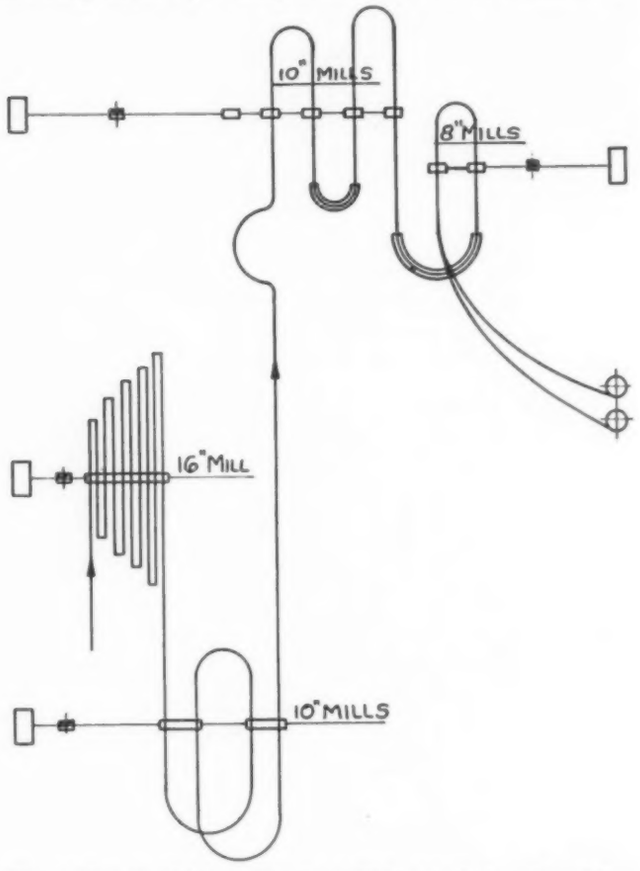


Figure 3 — In this layout, the mill is speeded up by adding two stands to the finishing train as well as adding an intermediate rougher.

TABLE I

Figure	Billet size	Minimum section finished	Coil weight minimum section	Number passes	Finishing speed, fpm	Crew*	Production, tons per hr
1	3½ in. sq	5/16 in. round	115 lb	24	1310	19	3.5
2	4⅛ in. round	¼ in. round	180 lb	22	1320	18	2.8
3	4 in. sq	9/32 in. round	150 lb	20	1040	22	2.5
4	4 in. sq	No. 5 round	165 lb	23**	1150	20	3.2
5	2 7/16 in. sq	9/32 in. round	175 lb	18	800	16	3.0
6	2¾ in. sq	¼ in. round	200 lb	20	1600	20	3.0

*This figure includes equipment operators, where applicable, furnace crew, and coil handling crew, but not spell hands, supervisory or inspection personnel.
**Including one dummy pass.

decrease rolling cost per ton by eliminating hand labor on the mill, and (6) at least double their rod capacity without having two rod mills.

From an examination of the preceding data, it can readily be seen that these objectives could not be met by a mill of the conventional type, since this type of mill had reached its logical limit of refinement.

Therefore, an entirely novel arrangement was adopted, as shown in Figure 7.

On this layout are shown (1) four double furnaces, (2) room for future continuous furnace discharging on extension of existing mill approach table, (3) two charging machines, (4) 18 in. mill approach table, (5) 18 in. mill, (6) 18 in. mill control pulpit, (7) tilting table and crop shear hydraulic drive, (8) 18 in. mill tilting table, (9) mill runout table, (10) transfer, (11) shear approach table, (12) shear, (13) shear gage table, gage, kick-off and cradles. This equipment provides an outlet for recogged billets, an arrangement which permits the use of the roughing mill to produce smaller billets for other mills in the plant.

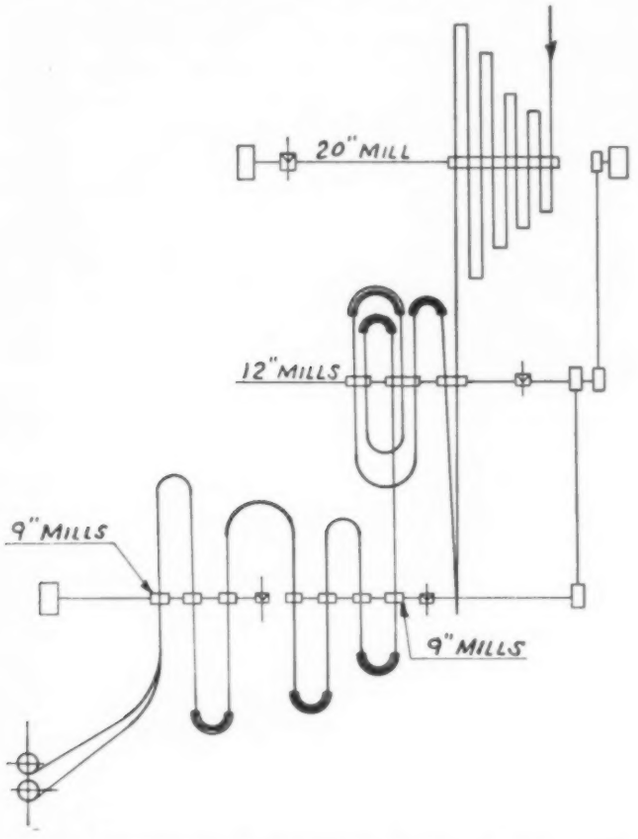


Figure 4 — This layout represents further progress in the design of rod mills.

Returning to the rod mill, are (14) the 12 in. mill approach table, (15) oval turning device, (16) 3-stand 12 in. mill with repeaters on both sides, (17) flying crop shear, (18) two-stand 9 in. mill and repeaters on both sides, (19) five-stand 9 in. mill with three stands on one drive, and two stands on another, and repeaters, (20) mill control pulpit, (21) five-stand continuous mill, (22) switches, (23) three coilers, (24) feeder coil conveyor, (25) main coil conveyor, (26) unloader, and (27) revolving bundle holder.

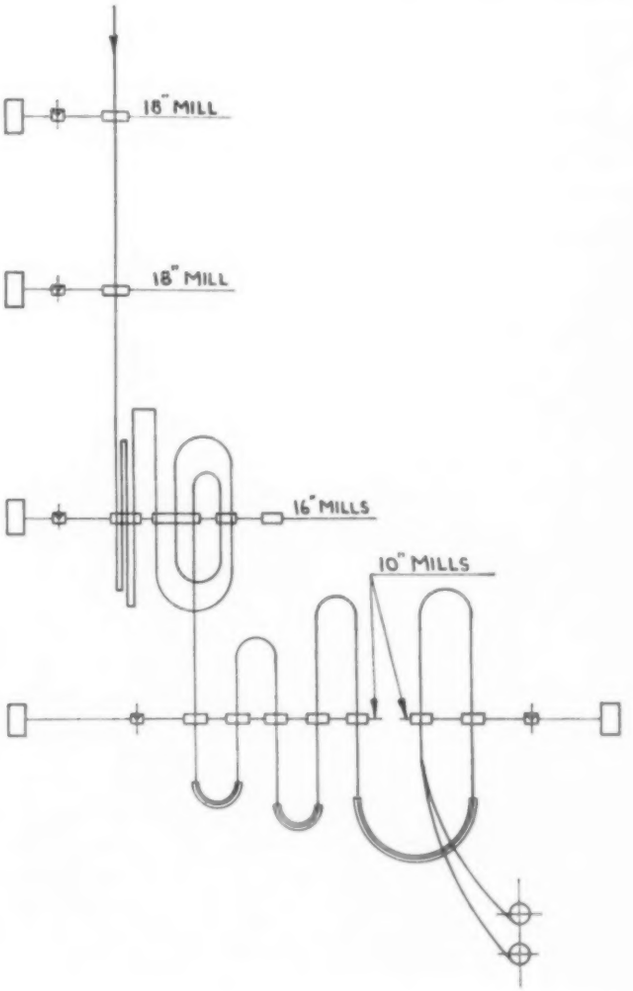
Ahead of the furnaces is the billet conditioning area from which billets for the mill originate, and the building in which the bundle holder is located contains rod conditioning equipment and wire drawing facilities, giving a straight line flow of material.

Figure 8 is a general view of the heating equipment. There are four double in-and-out type furnaces, oil fired, with automatic heating cycle control; each furnace has a hearth area of 243 sq ft, and a rated capacity of 4 tons per hour. They have developed a fuel rate of 41.0 gallons per ton.

The two charging machines are of floor type, with electric travel and swivel, and hydraulic tong lift and grip. The mill approach table is shown on the floor under the machine, arranged for maximum convenience in feeding the mill. An automatic shear for cropping the back end of the bar in the 18 in. mill is shown beside the table.

Figure 9 shows the front side of the 18 in. roughing mill. A feature of this stand is the cap, which is secured to the housing posts by four heavy shear pins, rather than by the conventional cap bolts. Pin clearance is taken up by wedges as shown. Thus the usual cap bolt arrangement, which contributes substantially to mill

Figure 5 — Mechanical handling first shows up in this rod mill design.



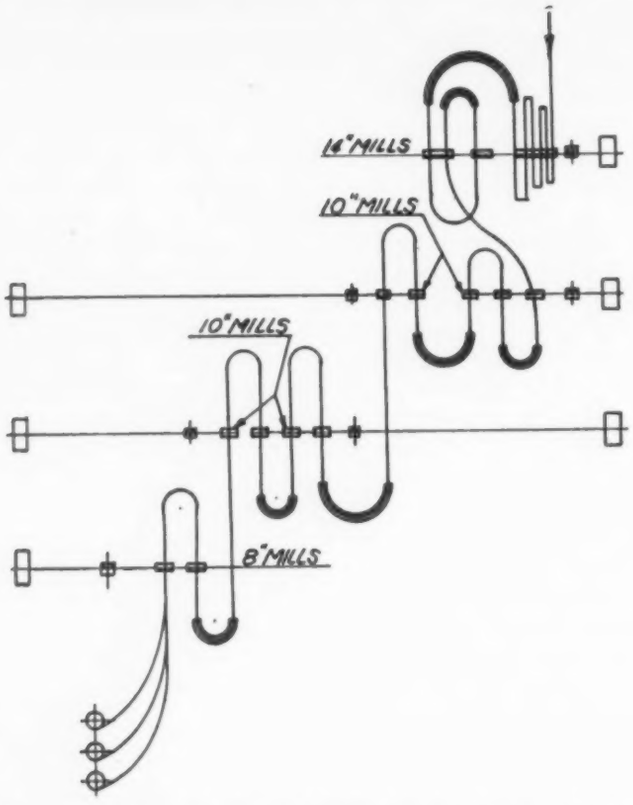


Figure 6 — One of the most recent layouts for rod mills.

stretch under rolling load, is eliminated, and the rigidity of a solid housing is obtained. In addition, the top roll is held up by a spring arrangement in the window, rather than by the conventional hanger bolts through the cap. The housing can be opened for roll changing by merely removing the wedges, two of the shear pins, and tilting the cap up on the other two. The rolls and chucks are then lifted out without further delay, and the cap is never removed from the stand.

The bottom screws are of stainless steel, to avoid rusting from mill water, and the gear box is totally enclosed.

Shown at the right is an automatic crop shear which crops the front end of the bar before No. 7 pass; hydraulically operated disappearing dog transfers handle the front end of the bar in and out of the shear. An additional automatic shear, which was shown in Figure 8, crops the back end of the bar.

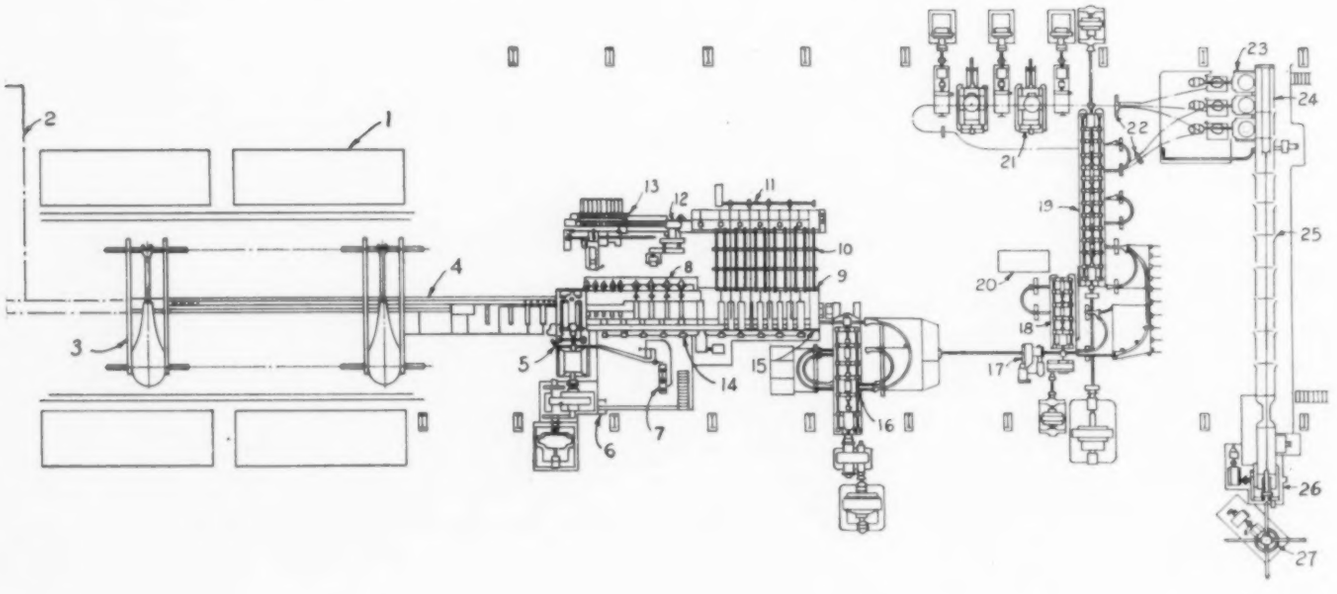
Just in front of the mill, at the mill approach table, is a disappearing stop, operated automatically from the tilting table, which prevents entry of a billet when the tilting table on the opposite side of the mill is up. In the event that more than one bar is worked in this stand at a time, this feature relieves the operators of the necessity of timing the billet approach carefully, since the billet cannot enter prematurely and go under the tilting table.

The tilting table on the back side of the 18 in. mill has individually driven rollers, which are ideal from a standpoint of rapid reversal and low maintenance. The table is balanced and actuated by an oil hydraulic system, giving smooth and rapid action. The sideguards shown are moved automatically by the tilting of the table. Their stroke is individually adjustable to suit the spacing of the passes, so that the bar is lined up with the next pass by the time the table is up. The man on the table is only required to turn up bars, when necessary. At the left of the tilting table is shown a separate non-tilting runout table for the last pass. This feature permits more than one bar to be worked conveniently in the mill at one time, without the necessity of synchronizing the initial passes with regard to the last pass.

The roughing mill is driven by a 600-hp, 600-rpm, a-c motor, through a reduction gear set with flywheels.

The 18 in. mill delivers an oval to the 12 in. mill, and an automatic oval turner is provided immediately ahead of the latter, to avoid a manual operation and

Figure 7 — An entirely new rod mill arrangement was adopted for the stainless mill at Rustless.



delay at this point. Figure 10 shows this turning device in operation. It is signalled by a flag switch in the approach table, and the bar does not pause at all in its travel. The oval is held by rollers, to avoid scratching.

The 12 in. mill has one two-high and two three-high stands, as shown in Figure 11, and is driven by a 600/1200-hp, 200/500-rpm, d-c motor. The middle stand should properly be two-high, but an existing three-high stand was utilized, and stools were made for this stand so top screws can be used throughout this mill. The picture also shows the double square repeaters on the back side, arranged to provide three or five passes, giving flexibility for the production of coarse or fine rods without disturbing the roll set-up in the finishing mills. This repeater arrangement is also convenient in compensating for variations in rolling characteristics of the many grades handled.

Elaborate precautions must be taken to prevent

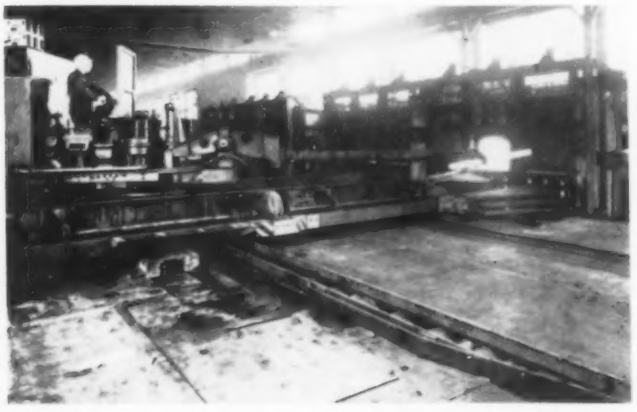


Figure 8 — The heating furnaces each have a rated capacity of 4 tons per hour.

scratching, and rollers have been provided at many critical points where the bar would otherwise rub. Some of these rollers are shown in this picture.

The repeaters on this mill start with a maximum square of $1\frac{5}{16}$ in. These bars are quite stiff in some of the grades handled, and very accurate adjustment of guides and repeaters is required. The ovals, especially, must be turned up properly to round the repeater and jump out without buckling, and considerable work was done by the mill personnel in setting repeaters and troughs, and in developing successful roller twisters. These twisters are shown in Figure 12. They are readily adjustable for various degrees of twist, and are provided with a scale to permit accurate resetting for various grades.

Between the 12 in. mill and 9 in. mill a flying shear is provided. This shear cuts approximately 1 in. square, at a maximum speed of 600 fpm and is driven by a 25-hp, d-c motor. It is shown in Figure 13. In back of the shear is a motor operated chain conveyor on which four crop buckets can be placed. The buckets can be spotted as required for scrap segregation.

The front and back ends of the bar are cropped after pass 10 or 12, as the case may be, and both cuts are initiated from the same flag switch, located in front of the shear, and are independent of bar length. In handling valuable material like stainless, economy is the watchword, and very accurate control has been pro-

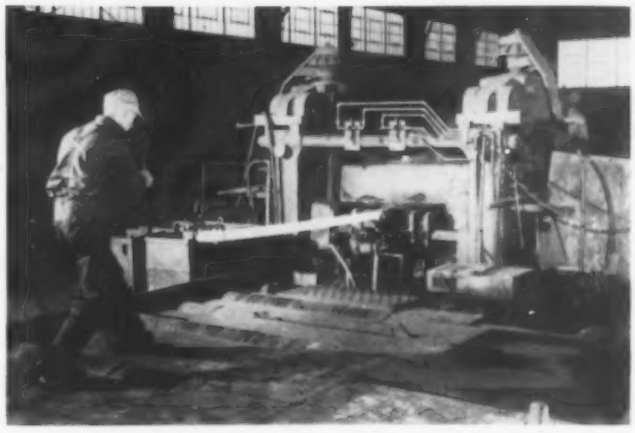


Figure 9 — An interesting detail of this roughing mill is that the cap is secured to the housing post by four heavy shear pins.

vided on the shear, so that length of crop can be held within an inch. In addition, the length of crop is readily adjustable from the nearby pulpit, to suit varying conditions in the bar.

The 9 in. mills have been laid out for maximum flexibility. Stands No. 1 and No. 2 are driven by a 350-hp, 300/500-rpm, d-c motor. Stands No. 3, No. 4, and No. 5 are driven by a 600/700-hp, 225/450-rpm, d-c motor, and stands No. 6 and No. 7 by a 350-hp, 300/500-rpm, d-c motor.

Repeaters are used on all square bars, and also on the oval between stands No. 1 and No. 2 and No. 3 and No. 4. For the square bars, a combination repeater is provided which repeats into No. 1 stand, or bypasses the first two stands and repeats directly into No. 3 stand, as required.

Figure 10 — An automatic oval turner is provided ahead of the 12 in. mill thus avoiding a manual operation.

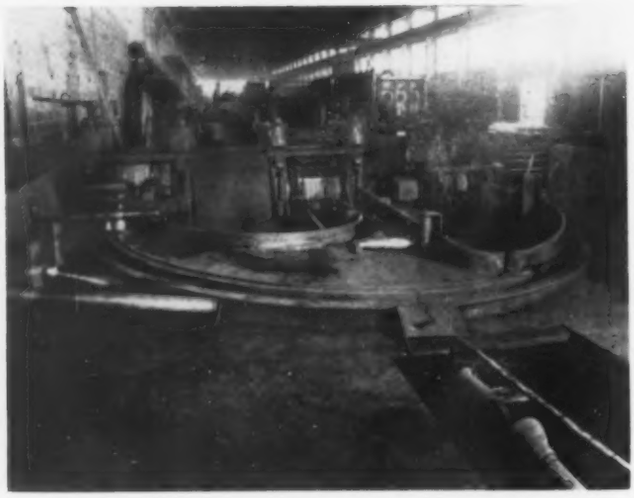


Figure 11 — The arrangement of the mill is convenient in compensating for the variation in the rolling characteristics of the many grades handled in the mill.

Figure 13 — A flying shear is provided between the 12 in. and the 9 in. mills.

One catcher is employed on the 9 in. mill, and the bar is cropped in front of stand No. 6.

The outstanding feature of the installation is a five-stand, 10 in. continuous finishing mill, with three horizontal and two vertical stands, shown in Figure 14. This mill makes it possible to finish at speeds up to 2800 fpm. This speed is double the maximum practical finishing speed for hand looping mills rolling stainless and alloy rod.

The bar is carried from the 9 in. mill to the continuous mill by guide pipe. A catcher loops it and crops as required.

The horizontal stands are shown at shop assembly in Figure 15. They are driven directly by d-c motors of 200-hp each, and speed ranges of 550/700, 650/950, and 775/1275-rpm. The stands have universal spindles of novel design, and totally enclosed water lubricated bearings. The spindles are disengaged by opening a set screw and sliding back a keyed sleeve. The whole spindle assembly is then held in position by a carrier arrangement, until ready to be engaged with a new set of rolls. The bearing arrangement permits recirculation of filtered water, and eliminates much of the flood of water over the mill equipment, which is the usual accompaniment of open, water lubricated bearings. Both bottom bearing chucks are individually adjustable vertically from the operating side of the stand, and the top chucks may be moved simultaneously or individually from the same side by means of a handwheel and clutch. Each chuck is adjustable endwise from the operating side, and the roll is held laterally in the chuck by a thrust flange, so that wear takeup may also be made directly from that side. Bearing thrust collars are not used on the roll body.

For maximum rigidity and ease of roll changing, the two chucks for each roll are made as one single casting, into which the rolls are fitted before assembly into the stands. The same arrangement of tilting cap with shear pins is used as was described in connection with the 18 in. mill stand. Sufficient grooves are provided in the rolls to handle all sizes finished in the continuous mill.

The vertical stands are shown at shop assembly in Figure 16. All the gearing and spindles which are usually connected with vertical stands have been eli-

Figure 12 — The roller twisters are easily adjustable for various degrees of twist.

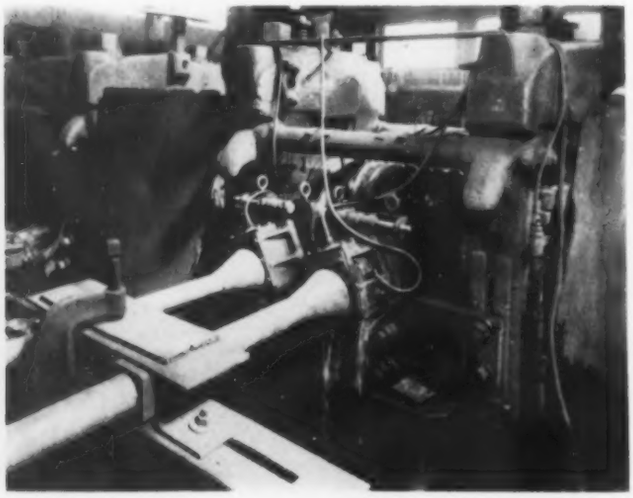


Figure 14 — The 10 in. continuous finishing mill has three horizontal and two vertical stands and finishes at speeds up to 2800 fpm.

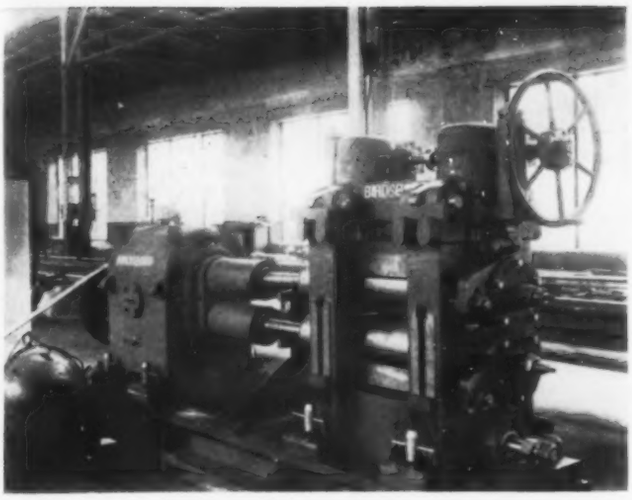


Figure 15 — Horizontal stands of 10 in. continuous finishing mill.

Figure 17 — Three coilers are used on the mill.

minated by mounting the motors directly on the stand. Each roll is driven by a separate motor, one mounted above the stand, and one mounted below. These motors are 100-hp, 450/650 and 600/900-rpm. The top roll spindle is fixed vertically and horizontally in the stand, and the bottom roll spindle is movable vertically and horizontally for pass adjustment by means of screws and wedges. Locking means are provided to hold the roll housing firmly in place after adjustment. In addition, the entire stand is movable horizontally on its shoe plate, so that it may be lined up with the proper pass in the horizontal stands.

The vertical rolls are in the shape of annular rings, keyed on the tapered spindle, and readily removable. For the roll which is under the top motor, an air operated roll changing rig is provided, which handles the roll on and off the spindle.

All adjustments are presently made by hand, but provision has been made for addition of motor traverse for the stand. In addition, the vertical roll has sufficient room for three passes, and vertical adjustment of the entire stand may be applied in the future, to utilize additional grooves without deflecting the rod from the horizontal pass line.

The electrical synchronization of these continuous stands was a very important matter, and is a proper subject for a separate paper. Suffice is to say that the mill operates successfully with no loop formation and no damaging tension. All of the finishing mills are controlled from the conveniently located mill pulpit.

We can note, at this point, that ten individual drives are used for the entire mill.

Air operated automatic switches are provided after the 9 in. and 10 in. mills, which switch the rods alternately into any one of three coilers, or any two of them. The guide piping from the 9 in. mill to the coilers has been fitted with numerous rollers to carry the rod around bends without scratching.

The three coilers are shown in Figure 17, together with the short feeder coil conveyor which removes them from the coilers and places them in position to be picked up by the main coil conveyor. This main conveyor has chain dogs spaced at convenient intervals, and automatically moves one space each time a coil is

Figure 16 — Vertical stands of 10 in. continuous finishing mill.

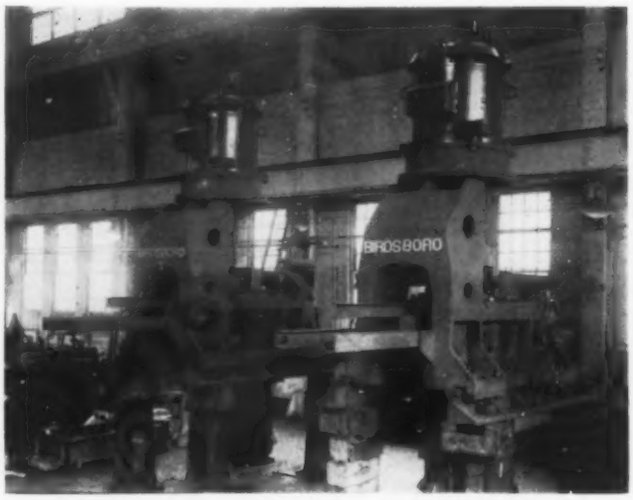


Figure 18 — The revolving bundle holder also provides convenient storage space.

delivered to it. At the same time a coil is automatically placed on the bundle holder. Between movements there is time to tie each coil at a tying station.

The revolving bundle holder is shown in Figure 18. When the desired number of coils is assembled on one arm, the holder is revolved through 90 degrees, and the bundle is removed by a fork truck as shown, from the 90, 180, or 270 degree positions. These three positions provide convenient coil storage space if required.

Proceeding now from the mechanical features of the mill to its operation, we find that an interesting series of combinations of stands is available for rolling various sizes with a minimum of roll changing, always using a 4 in. square billet.

These combinations are best shown by schematic

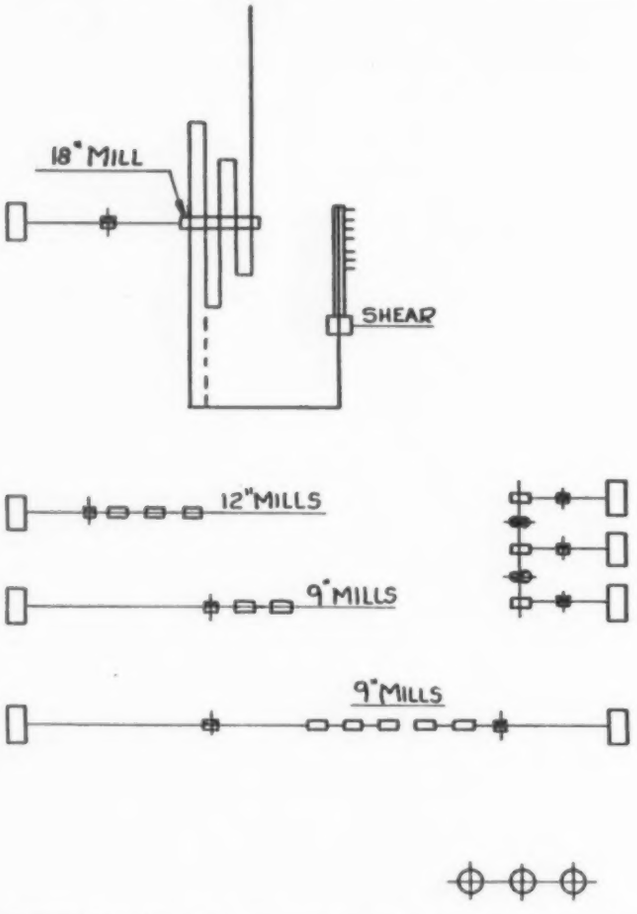


Figure 19 — Layout shown is used for recogging to make 2½ in. or 1⅝ in. square billets.

diagrams. Figure 19 covers recogging in the 18 in. mill to make billets of 2½ in. square or 1⅝ in. square in 5 or 7 passes.

Figure 20 shows the use of the 18 and 12 in. mills, and Stands No. 3, No. 4, No. 5, and No. 6 of the 9-in. mill. With this combination the billet is finished into rods of from $^{21}/_{32}$ in. diam to $^{17}/_{32}$ in. diam in fourteen passes.

By adding the 9-in. mill Stands No. 1 and No. 2, the combination shown on Figure 21 is obtained. On this combination rods of ½ in. to $^{7}/_{16}$ in. diam are finished in sixteen passes.

In Figure 22 two additional passes are added in the 12 in. mill, making a total of eighteen passes, and finishing $^{13}/_{32}$ and ⅜ in. diam rods in the 9 in. mill.

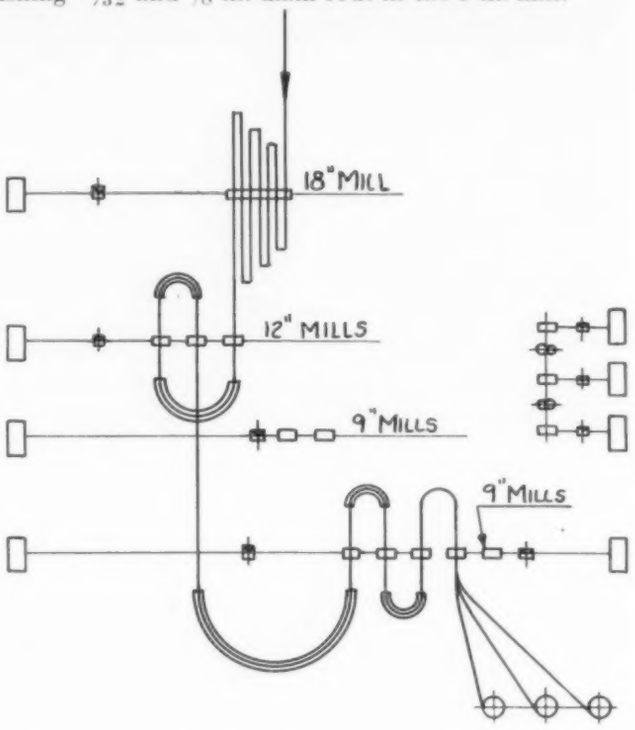
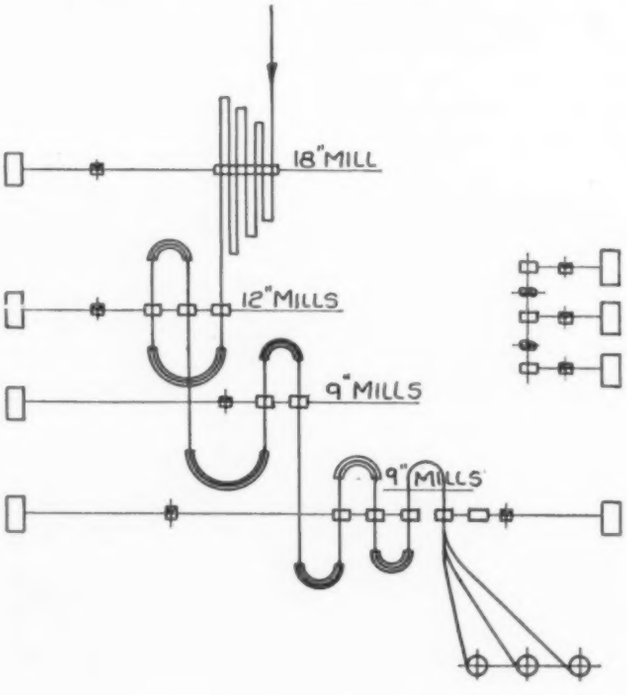


Figure 20 — With this layout, fourteen passes are used to finish 4 in. billets into 2½ in. and 1⅞ in. diameter rods.

Everything below ⅜ in. diam is finished in the continuous mill, and the arrangement for $^{11}/_{32}$ and $^{5}/_{16}$ in. diam is shown in Figure 23, with twenty passes.

The sizes are now reduced by adding Stands 1 and 2 of the 9 in. mill as shown in Figure 24. This arrange-

Figure 21 — On this combination, 16 passes are used to finish rods of ½ in. to 7/16 in. diameter.



ment finishes $^{9}/_{32}$ and $^{1}/_{4}$ in. diam rods in twenty-two passes.

The full 24 passes available are used as shown on Figure 25, for finishing No. 5 rod.

All sizes rolled on the mill use the same passes in the 18-in. mill, and the same rolls in the 12-in. and 9-in. and 10-in. horizontal stands, except that when finishing $^{3}/_{8}$ in. rods and larger, the finishing and lead oval roll in No. 5 and No. 6 stands of the 9-in. mill are changed.

The type of reduction taken in the various passes is shown in Figure 26.

The chart shows the type of passes used in making No. 5 rod from a 4 x 4 in. billet. Features of this arrangement are No. 1 pass, which is used to eliminate irregularities in the billet left from previous conditioning; the ovals in the second and third passes, for efficient scale removal, and the oval to oval series in the continuous stands.

We can now look at the operating results which have been obtained, to see how well the management at Rustless Division succeeded in meeting their objectives.

A 4 x 4 in. billet is successfully rolled to No. 5 rod in 260 lb coils. This size of coil seemed like a very optimistic goal at the time the mill was planned, but it is apparent now that a larger coil can be produced without detriment to quality. In the larger diameter rod, say $^{5}/_{8}$ in. diam, 385 lb coils have been produced.

Sixty-eight different analyses of stainless steel have been rolled successfully on the mill, out of the seventy

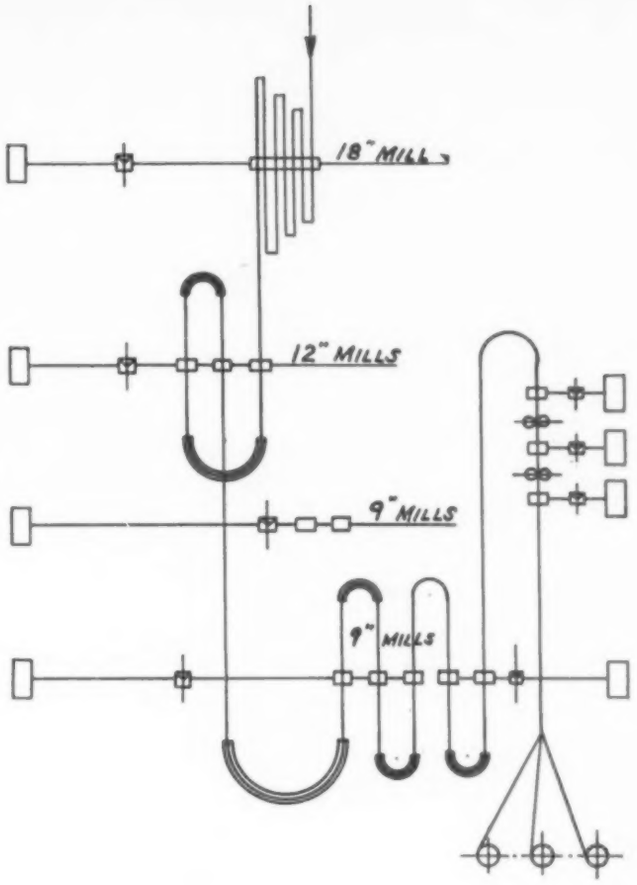
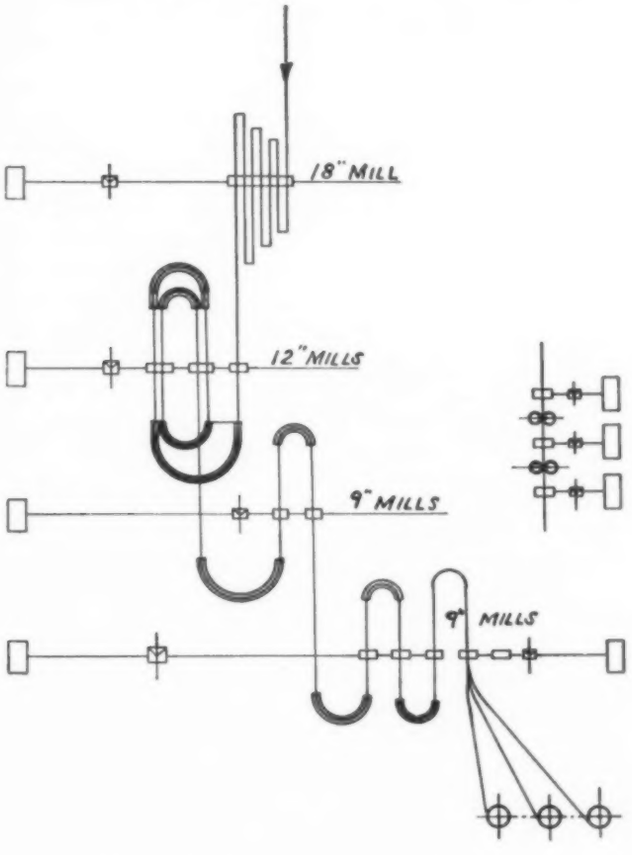


Figure 23 — The continuous mill is used to finish anything below ⅜ in. diameter.

Figure 22 — Pass layout for finishing $^{13}/_{32}$ in. and ⅜ in. diameter rod in 9 in. mill.



rollable analyses produced by this plant. All of the grades attempted have been rolled successfully.

The mill crew, not including spell hands, has been reduced to two men on the furnaces, two men on the roughing stand, one catcher on the 9-in. mill, and one catcher at the continuous mill. There are also three operators, one for the roughing mill, one to supervise speeds for the rest of the mill, and one for the coilers and conveyors; on the conveyor there is a man at the tying station, and a fork truck operator to remove bundles from the mill. There are the usual spell hands, millwrights and electricians, but the direct crew, as outlined above, amounts to eleven men.

With material as difficult to handle as stainless, it has been advisable to develop production rates very slowly. It is of interest to note, however, that production of 6.0 tons per hour of No. 5 rod, and 6.3 tons per hour of $^{1}/_{4}$ in. rod have been produced from the continuous mill, these being average figures for an 8-hour turn.

None of the above-mentioned achievements in economy of labor and increase in production would be of any significance, if the rods produced were not of the highest quality. Fortunately the entire mill arrangement favors the quality of the rod.

One of the problems in rolling stainless steels has been the necessity of rolling in a certain temperature range, often rather restricted. On the present mill, it takes 2 minutes 18 seconds from furnace to completed

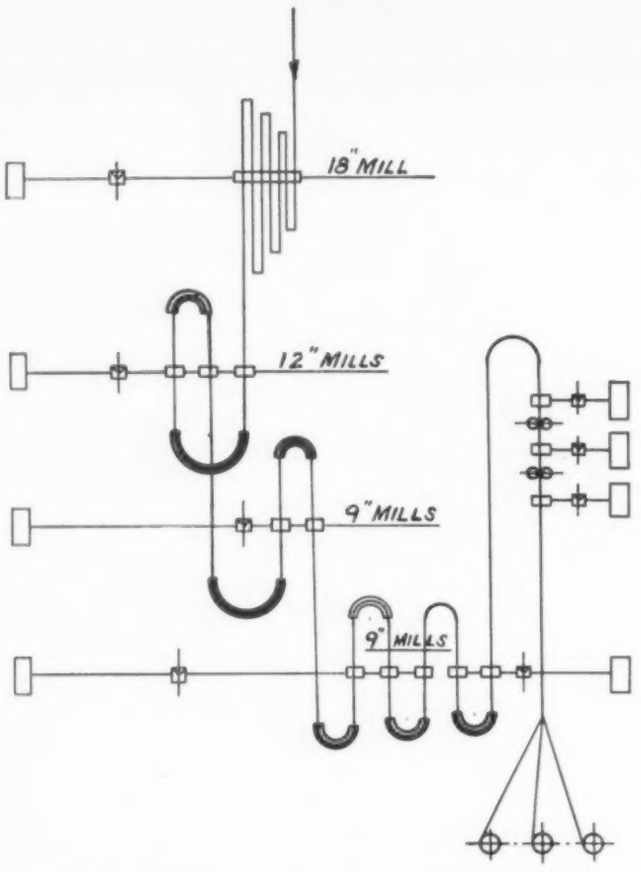


Figure 24 — Twenty-two passes are used to finish ½ in. and ¼ in. diameter rods.

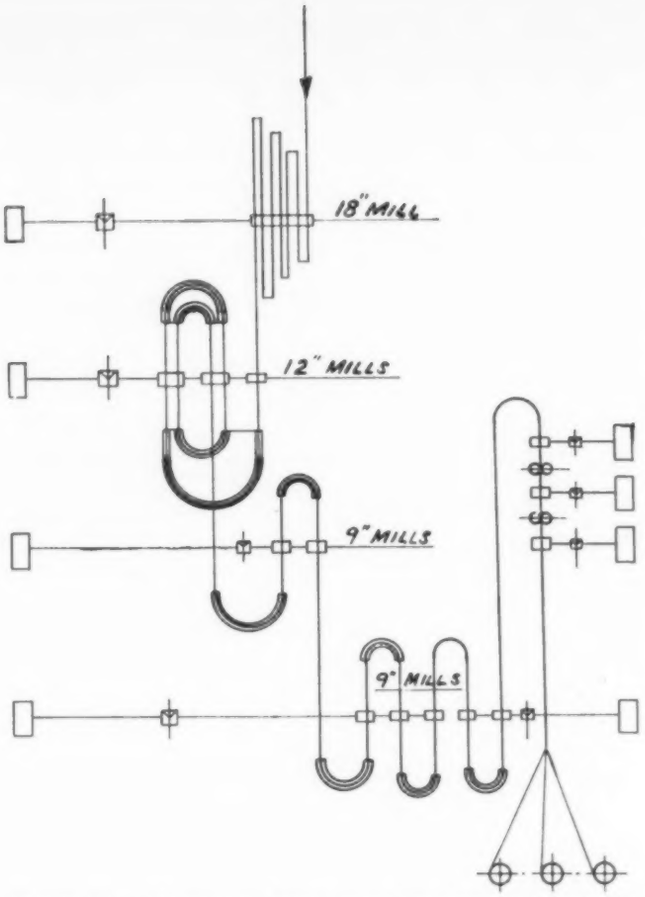


Figure 25 — All twenty-four passes are used to finish No. 5 rod.

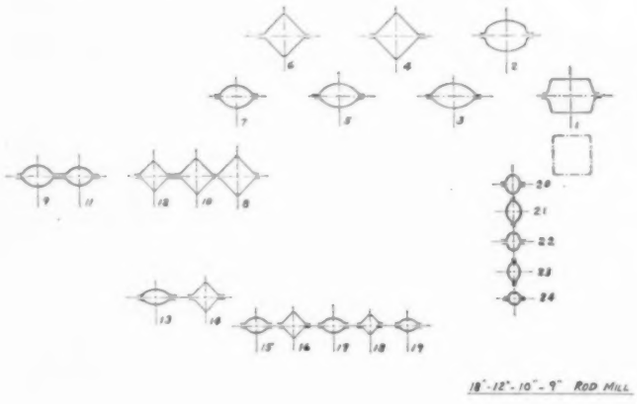
coil, rolling a 4 x 4 in. x 265 lb billet to ¼ in. round. The possibility of reducing temperature drop during rolling is obvious. As a matter of record, a 265 lb 4 in. billet taken from the furnace at 2200 F will finish coiling at 1720 F when rolled to ¼ in. diam rod; on the old mill a 110 lb 3 in. billet would finish coiling at 1500 F when rolled to $\frac{5}{16}$ in. diam rod.

Related to drop in temperature of the entire bar, is the problem of variation of temperature from end to end of each coil, reflecting itself in variation of both gage and physical properties; this drop is, of course, a function of finishing speed and length of loop in the finishing passes. The five-stand continuous mill has raised the possible finishing speed from around 1200 fpm, when catchers are used, as on a looping train, to 2800 fpm. In addition, the last four loops are eliminated. Temperature variation from end to end of a 260 lb coil of ¼ in. rod rolled from a 4 x 4 in. billet on the new mill has been measured as 150 F. In most mills, this cooling of the rod from front to back end causes a variation in gage of a few thousandths of an inch, normal to the roll axes, as the rolls are sprung open, and a considerably larger variation parallel to the roll axes, as the degree of filling of the pass varies. On the present mill, variation due to roll spring is not measurable, and variation due to pass filling is 0.006 in. maximum on ¼ in. diam rod in 260 lb coils.

Surface condition has been uniformly good. The tendency in mechanized mills has been to damage the surface by scratching and twisting. By eliminating twist in the finishing stands, by using roller twist guides throughout, and by careful roll design, the principal causes of surface defects have been eliminated. In addition, the mill operating personnel have been very energetic in detecting conditions which might cause scratching, and in eliminating them by proper adjustment and dressing of repeaters, guides, and guide piping, and the use of rollers to support the bar at critical spots.

Many new problems had to be met in creating this mill. All of those concerned with matters of operation, and electrical and mechanical design, gave generously of their time and experience, and worked in complete

Figure 26 — The reductions in the various passes are given in this figure.



coordination and harmony, with the full and effective support of the Rustless Division management.

The performance of the mill is a tribute to this sound approach.

DISCUSSION

PRESENTED BY

R. E. FINLAYSON, Superintendent Alloy Bar Mill, Carnegie-Illinois Steel Corp., Chicago, Ill.

LEWIS W. KING, Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

C. P. HAMMOND, Superintendent of Mills, Rotary Electric Steel Co., Detroit, Mich.

W. F. STRIGEL, Chief Roller, Rustless Iron and Steel Division, Armco Steel Corp., Baltimore, Md.

E. DAVIS, Superintendent Hot Mills, Carpenter Steel Co., Reading, Pa.

C. J. PETRY, Division Metallurgist, Hot Rolling, American Steel and Wire Co., Cleveland, Ohio

R. E. Finlayson: I would like to ask Mr. King if the mill points these billets before rolling, and if so, what grades are pointed? Also what guide material is used in this mill?

Lewis W. King: Pointing of billets is not necessary before rolling, because there is very little drop in temperature during the process of rolling and because the billets are cropped many times. Both ends are cropped after Passes No. 6 and 12. The front ends are cropped after Passes No. 15 and 19.

In answer to the second question, there are different materials used for entering and delivering guides. In the 18-in. roughing stand, cast iron entering and delivering guides are used. In the balance of the mill stands, roller bearing mounted roller entering guides made of rustless iron and steel materials are used. Cast iron delivery guides are used in all stands except in the five continuous stands, which are equipped with bronze delivery guides.

C. P. Hammond: I note the use of the 4 in. square billet, while the majority of the mills rolling rods have gone to smaller size billets. I would like Mr. King to elaborate on the advantages of the 4 in. square. He has mentioned the material being used in the guides, but I am interested in the type of material being used in the lead pipes from one stand to another, and from the continuous mill to the coilers, whether they use an ordinary pipe or some other material.

Lewis W. King: In answer to Mr. Hammond's question about the advantage or disadvantage of using a 4 x 4 in. billet over a 2½ x 2½ in. billet, the main advantage of using the larger cross section is the lower conditioning cost. In using the 4 x 4 in., which is a shorter billet than the 2½ x 2½ in., conditioning cost is lowered considerably, as compared to the conditioning cost of a 2½ x 2½ in. billet of the same weight. Rolling a 380 lb coil from a 2½ x 2½ in. billet would require furnaces deeper than are practical. In the hot working of high sulphur and selenium free machining grades, there is danger of the ends splitting, seemingly making it advantageous to use a 2½ x 2½ in. billet, which would require fewer passes than a 4 x 4 in. By cropping the front and back ends on the fly at the proper places, the rustless mill has been successful with the 4 x 4 in. billet and does not experience any trouble with split ends.

The materials in the pipes leading from stand to stand in the continuous mill, from the last stand of the Garret part of the mill to the continuous mill, from the roughing 12 in. mill to the flying shear, and from the mill into the coilers are all ordinary standard pipes, to my knowledge. There is nothing special about them. I would like to have Mr. Strigel verify that.

W. F. Strigel: That is correct.

E. Davis: I am very much interested in this mill. Down through the years we have heard that you cannot do this and you cannot do that with stainless that you can with carbon steels. Some of these things I have done myself that I was told could not be done, and some of the other things, I think, have been done by this new mill.

When we first started rolling stainless many years ago, we tried to put repeaters on the square side, which was some years back, and we had a little difficulty, of course, through the split ends.

I would like to ask Mr. King whether they found, through actual operation, that they required more shear points than they had originally set up.

Lewis W. King: In answer to Mr. Davis' question, they have added two more croppings and both are on the back end of the piece. The mill originally was designed to have four croppings, all on the front end. The added croppings are in the 18-in. mill and at the flying shear between the 12-in. mill and the 9-in. mill. Incidentally, the flying shear originally was designed to crop only the front end of the bar, but now it crops both ends. To my knowledge, no additional cropping seems to be needed.

C. J. Petry: I have three questions. First, is knurling used on any of the roughing passes? Second, what type of rolls are used and are all the rolls chilled or have you had to develop a special type of roll? Third, how much water is used on the passes, do you change the water for different grades, do you use any type of lubrication on the passes and do you use graphite on the rolls at any point?

Lewis W. King: In answer to Mr. Petry's first question, knurling is not used on any of the passes on this mill. In answer to the second question, conventional types of rolls are used throughout the mill. I will describe the rolls starting at the finishing end of the mill and working back to the roughing end. Chilled iron rolls are used in the five continuous finishing stands and the two preceding stands. They are also used in the leading oval and round finishing stands when finishing from the Garret part of the mill. Grain type rolls are used in the remaining stands except in the 18-in. roughing stand. In the 18-in. roughing stand, hard alloy steel rolls are used.

In answer to the third question, to my knowledge, there is no oil or graphite used on the passes.

W. F. Strigel: No oil or graphite is used. Water is used on all grades and in the same amount on all grades.

ELECTRICAL EQUIPMENT FOR A MODERN ROD MILL

By F. R. BURT
Westinghouse Electric Corp.
East Pittsburgh, Pa.

. . . . modern rod mills with their trend towards higher speeds and more continuous stands require more accurate electrical control to keep speed changes to the minimum required . . . .

▲ THERE is a definite trend toward the use of continuous mills in the production of rod. As compared with looping mills, higher speed can be utilized, the temperature is maintained at a higher value resulting in lower power costs, less space is required and labor cost is lower. However, the continuous mill with multiple stands driven by one motor has one outstanding disadvantage—its inflexibility. Since all stands are geared together, the per cent reductions through the mill are fixed. It is of advantage only in plants producing large tonnages in a very limited range of sizes.

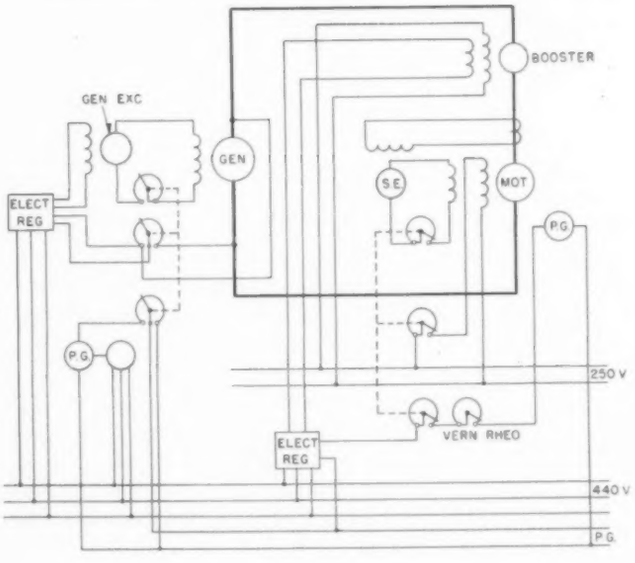
Flexibility of output requires that individual adjustment of the speed of each stand or of small groups of stands be possible so that the per cent reductions can be varied to suit different overall elongations. It is therefore necessary to drive each stand or group of stands by means of a direct current adjustable speed motor.

On a mill of this kind there can be no looping, and particularly where a precision product, or more than one strand, is rolled, the stretching should be kept to a minimum. In other words the speed relationship of the motors should be maintained as nearly constant as possible.

Any motor, regardless of how flat its steady state speed regulation is, drops in speed when a load is applied suddenly. The torque exerted by a motor is developed by the interaction of the flux and the armature current, and assuming the flux to remain constant, the armature current must increase to increase the torque. The current that will flow is proportional to the difference between the applied emf and the counter emf. Therefore, again assuming constant flux, it is necessary for the motor to decrease in speed to a point where sufficient current will flow to carry the required torque.

If the armature circuit were without inductance, this increase in current would follow any drop in speed instantly and the motor would settle smoothly to its new speed, which would be at a point where the difference between applied and counter emf would be just enough to allow sufficient current to flow to carry the torque.

Figure 1 — Simplified diagram of the connections of one stand motor with the common generator.



Presented before AISE Annual Spring Conference, Baltimore, Md., May 2, 1949

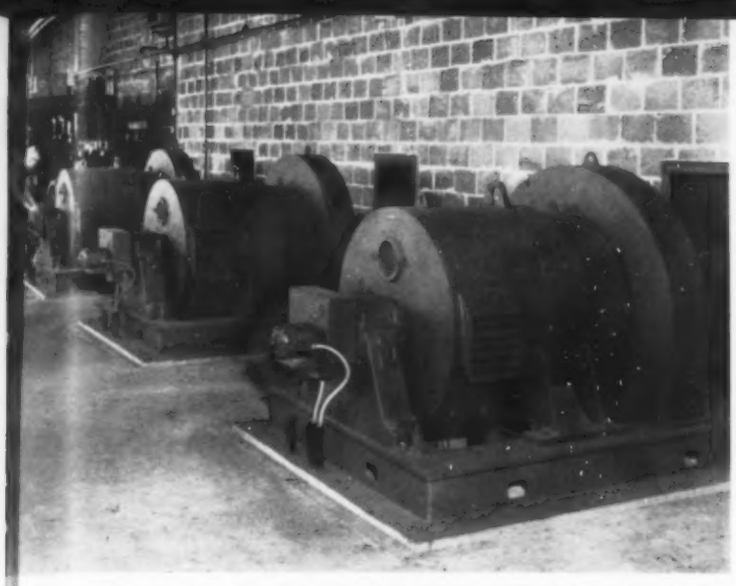


Figure 2 — These three 200-hp motors drive Stands No. 1, 3 and 5.

This difference in voltages is therefore the IR drop of the armature circuit, and the lower the IR drop the less will be the drop in speed.

However, armature circuits are inductive and resist sudden changes in current. Neglecting the effect of mechanical inertia for the moment, the armature inductance causes the increase in current to lag behind the drop in speed. At the instant when the speed has dropped to what will be the new steady state speed, the current has not yet increased to a value sufficient to carry the torque. The speed therefore continues to drop and the current to increase until the current reaches a value which will carry the torque. At this point the deceleration of the motor is arrested. However, the current continues to rise, since the motor is now at less than its steady state speed, and there is now an excess of torque over that required to carry the load.

This excess torque causes the motor to accelerate. As the motor accelerates and the counter emf approaches the applied emf, the current increases more slowly and then starts to decrease. At the point where it again crosses the steady state value the motor ceases to accelerate and starts to decelerate. The amplitude of these swings decreases rapidly and ordinarily after two or three cycles they are damped out by friction and armature resistance and the motor settles down at steady state speed.

At the instant the load is applied, the only energy available for carrying it is that mechanically stored in the drive, and the drive will decelerate just fast enough to that the stored energy will be given up at a rate sufficient to carry the load torque. The initial rate of deceleration is proportional directly to the load applied and inversely to the WR^2 of the drive. As the inductance of the circuit allows the armature current to build up, the motor assumes more and more of the load, less and less of the stored energy is required and the decelerating rate decreases.

If the WR^2 of the system is large enough or the inductance low enough so that the rate of change in speed is less than the rate of change in armature current, then there will be none of the overshooting described above, and the speed change from no load to load value will occur smoothly.

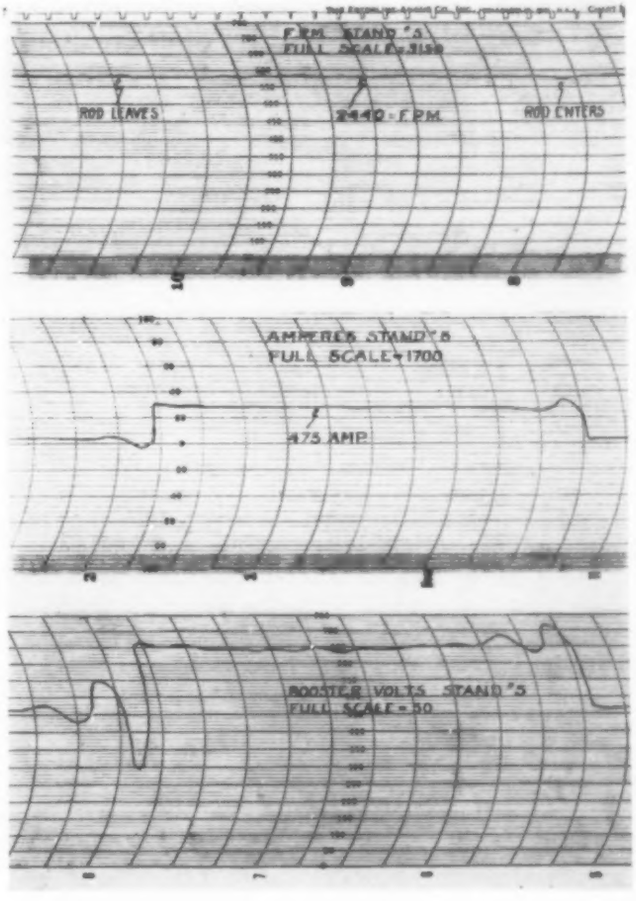
Direct current motors may be designed with flat steady state speed regulation by providing an inherent flux change in the motor with load, by means of a series field or series exciter, or an inherent change in applied voltage with load by means of a series booster, which involves a flux change in the booster. These means have little or no effect on impact drop. The final correction is only proportional to the change in armature current, and the change in current cannot anticipate the drop in speed. The required changes in flux lag so far behind the current changes that the impact drop is over before they can become effective.

However, it is possible, by the use of a suitable regulator, to force a correction in either the flux in the machine or in the applied voltage, which will very materially decrease the impact-drop. It has been found that by using sufficient forcing, a regulating system operating through a booster in the motor field circuit can be made almost as effective as one operating through a booster in the armature circuit.

No regulating system can start functioning instantaneously. Some initial speed drop before the regulator becomes effective cannot be avoided. However, by increasing the mechanical inertia of the drive, the initial rate of deceleration can be decreased to a point where a fast regulator can start correction before the speed has dropped more than a fraction of a per cent.

The finishing mill at the Rustless Iron and Steel

Figure 3 — These charts of the speed, load and booster volts on stand No. 5 show very close speed regulation.



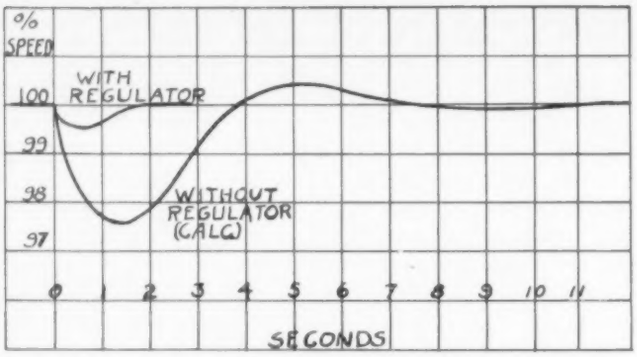


Figure 4 — The curve illustrates graphically the beneficial effect of the speed regulator.

plant consists of five tandem stands spaced on 6 ft centers, and individually driven by adjustable speed direct current motors. Only one strand is rolled, but a product of very uniform cross-section is required, and it was specified that the looping and stretching be kept to a minimum.

Stands No. 1, 3 and 5 are horizontal and are driven by direct connected motors through pinion stands. Stands No. 2 and 4 are vertical, and each stand is driven by two vertical motors—one driving each roll direct. One motor is located above the roll and drives downward and the other is located below and drives upward. All motors are force ventilated.

The ratings are as follows:

Stand No. 1—200-hp, 500/700-rpm.
Stand No. 2—2 x 100-hp, 450/650-rpm.
Stand No. 3—200-hp, 650/950-rpm.
Stand No. 4—2 x 100-hp, 600/900-rpm.
Stand No. 5—200-hp, 775/1275-rpm.

In order to meet the exacting requirements, it was decided to apply electronic speed regulators for holding and matching speeds, with added inertia in the form of separate flywheels mounted on the motor shafts inside the bearings. Each regulator uses as its cue the difference between the voltages of a pilot generator driven by the mill motor and that of a master pilot generator. This cue voltage, which indicates an error in speed, is amplified and impressed on the regulating field of a booster in series with the mill motor armature causing a change in impressed voltage, which corrects the stand speed until the pilot generator voltages again balance. Series exciters are used to improve the flat steady state regulation.

All stands are supplied with power from a common generator whose voltage is regulated by means of an electronic regulator acting on the exciter field.

A simplified diagram of the connections of the generator and one stand motor is shown in Figure 1.

The speed of all stands may be changed simultaneously by operating the generator rheostat. This rheostat has three sections, which are driven from the same shaft. The first section is in series with the main generator field. The second section is across the generator armature and is calibrated to maintain the input voltage to the regulator at a constant value as the generator voltage is changed. The third section is across the armature of the master pilot generator and recalibrates the speed pattern to correspond to the generator voltage.

The speed of any one stand may be changed individually by operating the stand rheostat, which is also in three sections. The first section is in the series exciter circuit and sets the series excitation at the proper value corresponding to the shunt excitation. The second section is in the motor shunt field, which is excited from the 250-volt bus, and the third section recalibrates the regulator for the new speed.

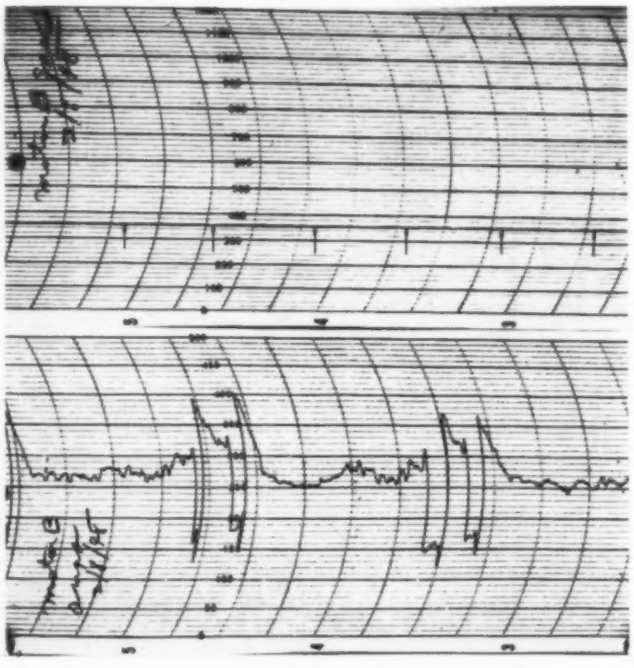
Complete operation of the mill is in the hands of an operator in an elevated pulpit on the mill floor.

The three 200-hp horizontal motors driving Stands No. 1, 3 and 5, with the control panels in the background, are shown in Figure 2.

Graphic meter charts of speed and load taken on this mill show that the speed is maintained within very close limits under varying conditions of load. Figure 3 shows the speed, load and booster volts on Stand No. 5, which happened to be carrying the highest load, during the rolling of one ¼ in. rod at 2440 fpm. The rolling load is 475 amp, which is approximately 75 per cent of full load. At the point where the rod enters there is a slight dip and at the point where the rod leaves there is a slight rise. It is very difficult to estimate the extent of these changes from the chart, but the variation in speed is not over one-half of one per cent and the time to recover is about one and one-half seconds. The speed matching is so close that the rod is carried between stands through a straight length of ¾ in. pipe.

Figure 4 is a calculated impact drop curve showing the drop which would be expected if this motor were operating under the same load and speed conditions as above, with compounding to give flat steady state speed regulation, and without the regulator. On this curve the speed dip shown in Figure 3 has been superimposed. Without the regulator the first dip would be

Figure 5 — On the top is shown motor speed on Stand No. 2 of the roughing mill, and on the bottom is shown the current. As can be seen, the large swings in current have no corresponding swings in speed.



2½ per cent and the first speed recovery would require approximately 3.8 seconds. This dip would result in a loop accumulation of approximately 18 in. of rod if the material were being delivered from the previous stand at 100 per cent speed. Under the same conditions, the dip shown with regulator operation would result in a loop accumulation of approximately 1.5 in. of rod.

These figures are only used as a means of comparison, since actually the rod is not being delivered from No. 4 stand at 100 per cent speed. On account of the short distance between stands, the preceding stand is still undergoing a change in speed due to its impact drop at the time the rod enters No. 5 stand. This results in an alternate stretching and looping effect, both of which are less than the loop accumulations mentioned above. The amount of stretching and looping depends on the relative loads on the two stands and on the speed at which the mill is operating.

With regulator control the operator can set up the mill for definite steady state speeds, with assurance that these speeds will be maintained within satisfactory operating limits under all conditions of loading.

Another interesting application at this plant is that of a flying rotary crop shear which automatically crops the front end of each rod after it leaves the roughing mill and before it enters the 10 in. intermediate mill. This shear is driven by a 25-hp mill type motor which operates over a speed range of 485/970 rpm by voltage control. The shear cycle is initiated by a flag switch operated by the front end of the rod, which energizes the shear drive control through an electronic timer. The shear is brought up to a speed which matches the rod delivery speed and makes one cycle under control of a high speed limit switch, which stops it after the cut, reverses it at low speed and brings it accurately to the initial setting. The electronic timer permits adjustment of length of crop without changing the position of the flag switch. The running speed is matched to the delivery speed of the previous stand by means of a rotating regulator.

Another mill of different arrangement, but in general involving the same problems, was placed in operation in the middle west at about the same time as the Rustless mill. This is a 19-stand, two strand rod mill, consisting of a 10-stand tandem roughing and intermediate mill driven by eight motors varying in horsepower from 200 to 600 and in speed range from 4:1 to 2.4:1, two looping stands driven by separate motors, and a 7-stand tandem finishing mill driven by a single motor. Maximum delivery speed is 3900 fpm.

Here the critical part of the mill is the roughing and intermediate portion. The spaces between centers is 72 in. except one, which is 54 in. Two strands are rolled and a new billet may be entered with the end of the previous billet anywhere in the mill. The motors vary in horsepower from 200 to 600, and the speed ranges by field control differ widely, up to a maximum of 4:1. A study of the problem involved resulted in a decision to apply added inertia and electronic regulators acting through series boosters to this part of the mill. Results have justified this decision. After being set up, the mill operates for long periods with very little attention from the operator and with hardly perceptible variations in speed.

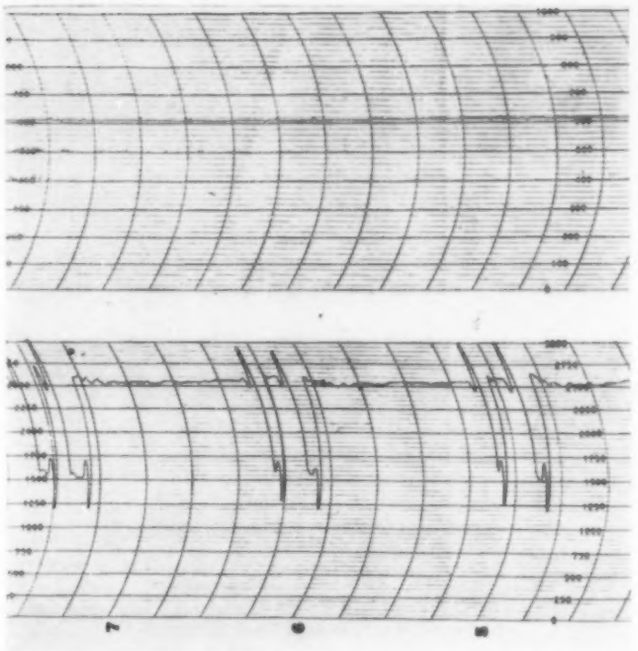


Figure 6 — On the top is given the speed and on the bottom the load on the motor which drives the 7-stand tandem finishing mill.

On the last three drives impact drop is not a problem, since the material loops between stands. Regulators were also applied to these drives, but without additional mechanical inertia, and with the regulators acting through boosters on the fields of the mill motors.

Figure 5 shows the speed and load on the motor driving Stand No. 2 of the tandem roughing mill. The points at which load swings of approximately 100 per cent occur cannot be distinguished on the speed chart.

Figure 6 shows speed and load on the motor driving the 7-stand tandem finishing mill, which is equipped with a regulator acting on the shunt field and no additional flywheel. Here speed changes of approximately 1.3 per cent occur due to impact drop, with load changes of approximately 60 per cent of full load torque. The speed, however, quickly recovers to steady state value.

DISCUSSION

PRESENTED BY

T. S. NOVAK, Assistant Electrical Engineer, Bethlehem Steel Co., Sparrows Point, Md.

F. R. BURT, Westinghouse Electric Corp., East Pittsburgh, Pa.

C. E. EMERSON, Chief Engineer, Rustless Iron and Steel Division, Armco Steel Corp., Baltimore, Md.

P. J. ROUMANIS, Application Engineer, Steel Mill Division, Industrial Engineering Divisions, General Electric Co., Schenectady, N. Y.

T. S. Novak: I would like to ask about the electronic

speed regulators. Normally, with electronic devices, the supply of voltage is very critical. Have there been any provisions made to maintain a constant supply of voltage on these regulators, and also do the regulators have to be recalibrated or readjusted every time a tube is replaced?

F. R. Burt: This is a speed-matching scheme and the cue for the regulator is the difference in voltage between the pilot generators. The regulator simply acts to reduce that error to zero, so that variations in the a-c voltage are not serious; at least the mill does maintain a very flat speed. On the matter of recalibrating the regulators when tubes are changed, I do not know whether that is necessary or not.

C. E. Emerson: Mr. Burt and Mr. Moore have given us evidence of the precise control which is obtainable by the use of electronic regulators. I can vouch for the fact that this equipment is doing an outstanding job at Rustless.

In answer to the question concerning the need for recalibrating the regulators from time to time, we have found that very little recalibration is necessary. As Mr. King and Mr. Peterson said, the flying shear is now doing twice the work that it was designed for, by cropping the front end and the tail end of the rods.

I have two questions. First, in selecting the size of motors for mills of this type which require such accurate speed control, is it necessary to over-horsepower the mills to avoid any possibility of overloads, or can the regulators and flywheels be depended on to take care of any substantial overload without interfering with the speed regulation?

The second question I have is this: In the specifications for the main generators supplying these motors, I believe a 5 per cent drop in voltage was required from zero to full load. I would like to ask why, when all the emphasis is on steady state conditions, should such a voltage drop be necessary to make the regulators function properly?

F. R. Burt: In applying motors to a mill of this kind, where regulators are used, we would not put any excess capacity in those motors to take care of overloads any more than we would if regulators were not used. It is true that the regulators force these motors and possibly cause slightly higher loads on them to get the flywheels back up to speed after a drop in speed than if the regulators were not there. However, due to the proportioning, the drop in speed is very little, so actually the power required to force it back up to steady state speed is very little, as you can notice on the charts I showed. The overloads on the motors were very small.

The inherent droop in generator voltage was specified in order to make sure that we had an inherently stable motor. We allowed the regulators to overcome that droop and give flat speed regulation.

P. J. Roumanis: The use of speed regulators to improve steady state speed characteristics of direct current motors is a well known story. However, the use of high inertia plus a high speed-high accuracy regulator to improve transient speed characteristics is a relatively new thought.

Our company first studied the problem of transient speed regulation of direct current motors as early as 1933. A paper discussing speed regulators for transient regulation was presented before the AISE spring convention in 1946. This paper disclosed that it was possible to build a speed regulator to limit transient speed regulation to one-half of one per cent if enough inertia was built into the drive.

Up to the present time we have built the drive for approximately 10 continuous rod mills. We have not yet found it necessary to use flywheels or speed regulators to obtain satisfactory performance. We have favored the use of the much less complicated system employing low impact speed drop motors.

Low impact speed drop motors have been successfully applied to the drive for two strand rod mills which are much more critical to speed changes than any other type of rod mill because one strand is already in the mill when the second strand enters.

These motors are specially designed to have low resistance to reduce the IR drop, low reactance to reduce the IX drop, and high inertia. It has been possible to build some of these motors to have an impact speed drop as low as 2½ per cent when full load is applied suddenly at base motor speed, and 2 per cent when applied at full speed. Furthermore, their speed-time characteristic is such that speed does not oscillate or recover. In other words, the motor slows down 2½ per cent, 3 cycles after the sudden application of full load, and continues to run at this speed until load is removed. As has been discussed in previous papers, this type of motor characteristic is desirable for tandem rod mill drives. An analysis of the speed of two successive stands shows that the rod is slightly stretched when it enters the second stand until the second stand drive motor assumes its loaded speed. However, since the speed does not increase above this value, looping is essentially prevented. The time needed for the motor to change from no load speed to loaded speed is about $\frac{1}{20}$ of a second, or three cycles on a 60 cycle base. Thus it can be seen that the length of off gage product due to speed change is negligible.

The problem of transient speed regulation is much more critical in a tube mill where the problem of ballooning is added to those of a rod mill. We have applied speed regulators to a recently installed tube mill.

When building the drive for a rod mill, we analyze the problem considering such factors as the number of stands per motor, number of strands, stand spacing, product size, and speed. We do not use speed regulators unless the results of this analysis lead the purchaser to feel that the product will benefit and that the added expense and complications of speed regulating equipment are justified.

In closing, I would like to take this opportunity to ask Mr. Burt why it was felt that series exciters were needed when high accuracy speed regulators were also used.

F. R. Burt: Our experience has shown that the regulators would probably take care of any variations without the use of series exciters. However, at the time this equipment was designed it was decided to use series exciters in order to make sure that the maximum in speed regulation was attained and in order to reduce the demands on the regulator.

Coke and By-Products in 1948

. . . data from Mineral Market Report, M.M.S. No. 1748, June 1949 . . .

▲ THE annual canvass of coke producers in the United States conducted by the Bureau of Mines, Department of the Interior, showed that more coke was produced in 1948 than at any time in the history of the industry. The 1948 production amounted to 74,861,928 net tons. This was 1,416,078 tons (2 per cent) more than in 1947 and 824,111 tons (1 per cent) more than the wartime peak in 1944. Although output of beehive coke declined 109,730 tons, production at coke-oven plants was 1,525,808 tons more than in 1947.

The quantity of coal carbonized in coke ovens was also the greatest on record; but the quality was not up to the usual high standard because a large proportion of inferior coal was purchased in the first part of 1948 in anticipation of interruptions in coal production. As a result, the yield of coke per ton of coal dropped from 69.91 per cent in 1947 to 69.60. Coal purchased in the latter part of 1948, however, was much better for coking and the yield of coke should improve in 1949. Coal costs at the ovens reached new peaks in 1948 because of increases in mining and transportation costs. The average value of coking coal at oven-coke plants increased $1.35 per ton over 1947, and at beehive-coke plants, $0.68 per ton. The rise in coal costs resulted in increases in coke prices and the average value per ton of all coke sold on the open market advanced as follows: furnace coke, $2.68; foundry coke, $3.81; water-gas coke, $2.25; other industrial coke, $2.37; and domestic coke, $1.98.

The heavy demand for metallurgical coke (blast furnace and foundry) continued in 1948 and 63,036,165 tons were consumed for this purpose, or 85 per cent of all coke sold and used by producers; 7,733,382 tons, or 10 per cent, went for other industrial uses; and 3,445,309 tons, or 5 per cent, for domestic heating. Coke for household use has declined markedly since 1940 when 14 per cent of all coke sold was so used. Despite the increased consumption of coke in 1948, producers' stocks at the end of the year amounted to 1,593,441 tons, an increase of 561,204 tons, or 54 per cent.

Production of the principal coal chemicals increased in 1948, although yields per ton of coal carbonized decreased because of the poor quality of the coal charged and the high rate of oven operation. Tar production increased 2,580,626 gallons over 1947; ammonium sulphate or equivalent, 34,763,170 pounds; gas, 23,590,346 M cubic feet; and crude light oil, 1,110,602 gallons. The total value of coke and breeze produced, and coal-chemical materials sold in 1948 reached an all-time high of $1,230,234,113.

PRODUCTION OF COKE

In 1948 the average daily rate of by-product coke averaged 187,000 tons; the average daily production in beehive ovens was 18,000 tons. The leading states in order of importance in the manufacture of by-product coke were Pennsylvania, Ohio, Indiana, Alabama and New York. These states combined produced about 47,500,000 tons or about 69.6 per cent of the national production of oven coke. The leading producer of beehive coke was Pennsylvania with 5,733,835 tons or 87 per cent of the total beehive production. Of all coke produced, Pennsylvania was by far the leading producer, with about 22,384,000 of the total 74,862,000 tons or 30 per cent.

NUMBER AND CAPACITY OF OVENS

At the end of 1948, there were 15,139 coke ovens in existence with a total capacity of 74,499,900 net tons. An additional 350 ovens with a capacity of 1,880,500 net tons were under construction at the end of the year. During the year, 495 ovens with a capacity of 2,571,700 tons were added to the industry's capacity and 84 ovens were abandoned during the year. There were 14,078 beehive ovens in existence at the end of the year with a capacity of 9,076,200 tons and the rehabilitation of 1120 ovens during the year added that number to average capacity. Only 485 beehive ovens were abandoned during the year.

COAL CHARGED INTO COKE OVENS

In 1948, 107,305,711 net tons of coal were charged into coke ovens and of this total 96,984,143 tons valued at $788,778,359 or $8.13 a ton were charged into by-product coke ovens and 10,321,568 tons valued at $52,738,368 or $5.11 a ton were charged into beehive ovens. An additional 256,175 tons of anthracite valued at $1,672,248 ($6.53 a ton) were charged into by-product coke ovens.

The cost of coal (1.42 tons) required to make one ton of by-product coke was $11.58 in 1948. Similarly, the

TABLE I

Statistical Trends of the Coke Industry in the United States

	1937	1945	1946	1947	1948
Production:					
Oven coke, net tons	49,210,748	62,094,288	53,929,447	66,758,549	68,284,357
Beehive coke, net tons	3,164,721	5,213,893	4,568,401	6,687,301	6,577,571
Total, net tons	52,375,469	67,308,181	58,497,848	73,445,850	74,861,928
Per cent oven coke	94.0	92.3	92.2	90.9	91.2
Stocks of coke, end of year, net tons	2,595,287	931,813	928,766	1,032,237	1,593,441
Exports, all coke, net tons	526,683	1,478,746	1,231,327	835,059	706,190
Imports, all coke, net tons	286,364	51,964	52,188	104,093	161,400
Indicated consumption, all coke, net tons	51,271,929	66,074,271	57,321,756	72,611,413	73,755,934
Disposal, all coke sold or used:					
Furnace coke, net tons	36,751,969	51,002,921	43,700,492	57,636,505	59,285,506
Foundry coke, net tons	2,038,822	2,636,731	2,996,202	3,650,001	3,750,659
Other industrial coke (including producer and water gas), net tons	4,597,894	6,937,553	6,593,870	8,028,791	7,733,382
Domestic coke, net tons	8,107,518	6,775,508	5,096,733	3,977,328	3,445,309
Carbonizing equipment:					
Coke ovens in existence, end of year	12,718	14,510	14,494	14,728	15,139
Beehive ovens in existence, end of year	12,194	12,179	12,864	13,443	14,078
Coke ovens under construction, end of year	259	335	824	572	350
Cost of coal charged, oven-coke plants, average per ton	$3.74	$5.28	$5.77	$6.78	$8.13
Prices of coke:					
Average spot price of Connellsville furnace coke, fob ovens	$4.29	$7.29	$8.13	$10.49	$13.44
Average realization on oven coke sold (merchant sales):					
Furnace coke	$4.34	$7.87	$8.85	$10.95	$13.78
Foundry coke	$8.47	$11.48	$12.62	$14.79	$18.78
Other industrial coke (including water gas)	$6.08	$8.35	$9.58	$11.13	$13.45
Domestic coke	$6.53	$8.69	$9.90	$11.19	$13.17
Yield of by-products per ton of coal charged:					
Tar, gal	8.67	7.95	7.82	7.78	7.60
Ammonium sulphate or equivalent, lb	21.84	20.22	19.79	19.66	19.52
Crude light oil, gal	2.86	2.84	2.77	2.75	2.73
Surplus gas sold or used, cu ft	6.66	6.33	6.29	6.27	6.25
Average gross receipts for by-products, per ton of coke produced:					
Tar sold and used	$0.502	$0.447	$0.466	$0.605	$0.828
Ammonia and its compounds	$0.326	$0.356	$0.361	$0.423	$0.545
Crude light oil and its derivatives (including naphthalene)	$0.435	$0.503	$0.467	$0.566	$0.685
Surplus gas sold or used	$1.483	$1.413	$1.542	$1.678	$1.839
Total coal-chemical materials (including breeze)	$2.974	$3.069	$3.207	$3.710	$4.419

cost of coal (1.57 tons) required to make one ton of beehive coke was $8.02 per ton. The trend towards washed coal continues and of the 97,240,318 tons of coal charged into by-product ovens, over 28,529,290 tons were washed. At the beehive ovens 1,896,513 tons were washed of the 10,321,568 tons charged.

The leading states in mining coking coal in order of importance are West Virginia, Pennsylvania, Kentucky and Alabama. Of the 100,372,727 tons of coal produced, West Virginia produced 36,318,250 tons; Pennsylvania, 32,278,200 tons; Kentucky, 14,575,772 tons and Alabama was fourth with 8,822,325 tons.

COKE PRODUCED AND SOLD OR USED BY PRODUCERS

The total quantity of coke reported used in blast furnaces was 59,128,129 tons in 1948 or 80.2 per cent of the total. The coke used per net ton of pig iron and ferro-alloys was 1937.2 lb per net ton in 1948. Since the yield of coke from coal was 69.6 per cent, this meant that 2783.3 lb of coking coal were used per net ton of pig iron and ferro-alloys. The comparable figure of the American Iron and Steel Institute of 1908 lb of coke per net ton of pig iron in 1948 excludes the furnaces which make ferro-alloys. The total sales of by-product and beehive coke to other than affiliated companies was 6,452,269 tons. Coke sold for domestic fuel was 3,445,309 tons.

STOCKS OF COKE AND COKING COAL

According to reports from by-product coke plants, at the end of 1948 stocks of furnace and foundry coke totaled 947,730 tons, domestic and other coke stocks totaled 612,851 tons and the stock of coke breeze was 1,485,710 tons. Stocks at beehive coke plants were much less, and coke for furnace and foundries at beehive plants totaled 31,593 tons; domestic and other totaled 1267 tons and stocks of coke breeze totaled 6231 tons.

Normally stocks of bituminous coal held by the by-product operators will follow the trend of monthly production. However, this rate varied throughout 1948 because of the labor situation in the coal mining industry. Strikes and disturbances to working time had marked effect in coal stocks as well as the efforts on the part of some operators to build up stocks for the emergency. In January, 1948 coal stocks at by-product plants were 8,670,875 tons and this dropped to a low of 4,307,878 tons. The stock was built up to 10,474,191 tons in June, dropped to 8,974,663 tons in July and then gradually built up to the largest stock of the year or 12,104,428 tons in December 1948.

GROSS VALUE AND YIELD OF BY-PRODUCTS

The gross value of by-products sold in 1948 (exclusive

TABLE II

Salient Statistics of the Coke Industry in the United States in 1948

		By-product	Beehive ovens	Total
Coke produced — At merchant plants	net tons	13,332,499	(1)	(1)
At furnace plants	net tons	54,951,858	(1)	(1)
Total	net tons	68,284,357	6,577,571	74,861,928
Screenings or breeze produced	net tons	5,765,576	108,267	5,873,843
Coal charged into ovens	net tons	97,240,318	10,321,568	107,561,886
Average value of coal per ton		$8.13	$5.11	$7.84
Average yield in per cent of total coal charged —				
Coke		70.22	63.73	69.60
Breeze (at plants actually recovering)		5.93	2.72	5.46
Ovens — In existence January 1		14,728	13,443	28,171
In existence December 31		15,139	14,078	29,217
Dismantled during year		84	485	569
In course of construction December 31		350	.....	350
Annual coke capacity, December 31	net tons	74,499,900	9,076,200	83,576,100
Coke used by producer — In blast furnaces	net tons	38,995,137	261,789	39,256,926
In foundries	net tons	91,670	.....	91,670
To make producer gas	net tons	800,056	.....	800,056
To make water gas	net tons	1,511,310	.....	1,511,310
For other purposes	net tons	414,157	3,160	417,317
Coke sold — To financially affiliated companies —				
For blast furnace use	net tons	12,021,531	1,554,780	13,576,311
For foundry use	net tons	62,056	.....	62,056
For manufacture of water gas	net tons	685,197	.....	685,197
For other purposes	net tons	247,144	5,752	252,896
To other consumers —				
For blast furnace use	net tons	2,936,675	3,515,594	6,452,269
For foundry use	net tons	3,100,181	496,752	3,596,933
For manufacture of water gas	net tons	1,546,592	204,254	1,750,846
For other industrial use	net tons	1,847,245	468,515	2,315,760
For domestic use	net tons	3,398,696	46,613	3,445,309
Disposal of screenings or breeze —				
Used by producer — For steam	net tons	3,625,109	15,623	3,640,732
To make producer or water gas	net tons	147,131	.....	147,131
For other purposes	net tons	773,636	6	773,642
Sold	net tons	1,121,611	43,384	1,164,995
Average receipts per ton sold (merchant sales) —				
Furnace coke		$13.78	$12.39	$13.02
Foundry coke		$18.78	$15.06	$18.26
Water-gas coke		$13.10	$13.05	$13.10
Other industrial coke		$13.74	$13.48	$13.69
Domestic coke		$13.17	$11.88	$13.15
Screenings or breeze		$4.11	$2.32	$4.05
Stocks on January 1, 1949 — Furnace coke	net tons	940,727	30,629	971,356
Foundry coke	net tons	7,003	964	7,967
Domestic and other coke	net tons	612,851	1,267	614,118
Screenings or breeze	net tons	1,485,710	6,231	1,491,941
Exports	net tons	(1)	(1)	706,190
Imports	net tons	(1)	(1)	161,400
Indicated consumption	net tons	(1)	(1)	73,755,934
By-products produced Tar	gal	738,755,106	.....	738,755,106
Ammonium sulphate or equivalent	lb	1,859,386,041	.....	1,859,386,041
Gas	M cu ft	994,852,626	.....	994,852,626
Burned in coking process	per cent	37.26	.....	37.26
Surplus sold or used	per cent	61.09	.....	61.09
Wasted	per cent	1.65	.....	1.65
Crude light oil	gal	256,089,065	.....	256,089,065
Yield of by-products per ton of coal —				
Tar	gal	7.60	.....	7.60
Ammonium sulphate or equivalent	gal	19.52	.....	19.52
Gas	M cu ft	10.23	.....	10.23
Crude light oil	gal	2.73	.....	2.73
Coal used per ton of coke	tons	1.42	1.57	1.44
Value of coke at ovens		$848,719,083	$79,562,771	$928,281,854
Value of screenings or breeze		$20,017,861	$241,290	$20,259,151
Value of by-products sold — Tar —				
Sold		$41,957,748	.....	$41,957,748
Used by producer		$14,566,552	.....	$14,566,552
Ammonia (sulphate and liquor)		$37,179,268	.....	$37,179,268
Gas (surplus)		$125,555,996	.....	$125,555,996
Crude light oil and derivatives		$42,220,588	.....	$42,220,588
Other coal-chemical materials (2)		$20,212,956	.....	$20,212,956
Total value of coke and breeze produced and coal-chemical materials sold (3)		$1,150,430,052	$79,804,061	$1,230,234,113

(1) Not separately recorded. (2) Naphthalene. tar derivatives, and miscellaneous coal-chemical materials.
(3) Includes value of tar used by producer.

TABLE III

Coke Produced, Value, Number of Ovens, Coal Charged, and Average Yield in the United States in 1948, by States
(Exclusive of screenings or breeze)

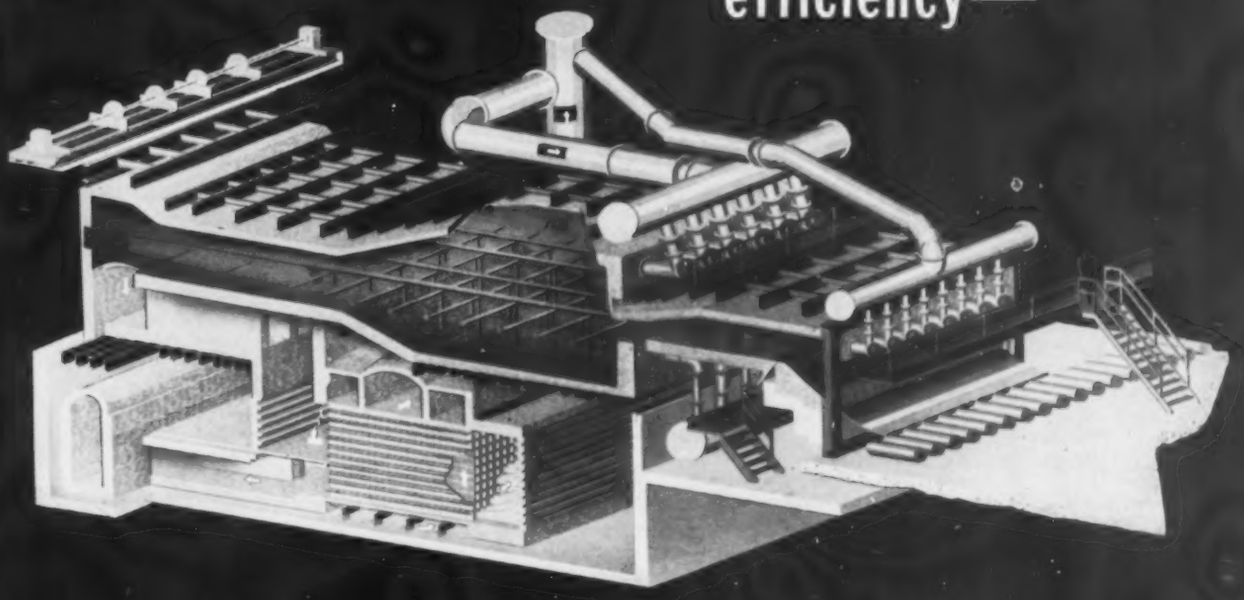
State	Oven coke						
	Plants	Ovens	Coal charged (net tons)	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens	
						Total	Per ton
Alabama	7	1,311	8,410,868	71.52	6,015,460	$57,611,881	$9.58
California	1	90	482,289	61.53	296,749	(1)	(1)
Colorado	1	262	1,413,355	69.09	976,504	(1)	(1)
Illinois	8	852	5,221,320	70.39	3,675,284	54,396,850	14.80
Indiana	5	1,863	11,884,929	72.23	8,584,225	125,355,310	14.60
Maryland	1	483	3,005,794	71.45	2,147,787	(1)	(1)
Massachusetts	2	215	1,478,402	71.48	1,056,701	(1)	(1)
Michigan	4	568	4,000,171	71.24	2,849,601	39,637,987	13.91
Minnesota	3	196	1,178,266	71.82	846,246	12,425,815	14.68
New Jersey	2	304	1,956,052	72.13	1,410,941	(1)	(1)
New York	8	1,142	8,204,974	69.31	5,687,225	72,756,957	12.79
Ohio	15	2,292	14,960,890	70.60	10,562,486	128,843,686	12.20
Pennsylvania	13	3,852	24,229,905	68.72	16,649,689	189,729,879	11.40
Tennessee	1	44	342,466	73.42	251,428	(1)	(1)
Texas	2	125	907,830	70.96	644,225	(1)	(1)
Utah	2	308	1,741,411	60.78	1,058,501	(1)	(1)
West Virginia	5	718	4,738,217	69.61	3,298,090	33,090,297	10.03
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	6	514	3,083,179	73.73	2,273,215	32,259,021	14.19
Undistributed	....	....	.....	.....	.....	102,611,400	13.08
Total 1948	86	15,139	97,240,318	70.22	68,284,357	848,719,083	12.43
At merchant plants	31	2,983	18,672,468	71.40	13,332,499	191,564,563	14.37
At furnace plants	55	12,156	78,567,850	69.94	54,951,858	657,154,520	11.96
Total 1947	86	14,728	94,587,328	70.58	66,758,549	711,100,409	10.65

State	Beehive coke						Total	
	Ovens	Coal charged (net tons)	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens		Coke produced (net tons)	Value of coke at ovens
					Total	Per ton		
Alabama	.....	.....	.....	.....	.....	.....	6,015,460	$57,611,881
California	.....	.....	.....	.....	.....	.....	296,749	(1)
Colorado	.....	.....	.....	.....	.....	.....	976,504	(1)
Illinois	.....	.....	.....	.....	.....	.....	3,675,284	54,396,850
Indiana	.....	.....	.....	.....	.....	.....	8,584,225	125,355,310
Maryland	.....	.....	.....	.....	.....	.....	2,147,787	(1)
Massachusetts	.....	.....	.....	.....	.....	.....	1,056,701	(1)
Michigan	.....	.....	.....	.....	.....	.....	2,849,601	39,637,987
Minnesota	.....	.....	.....	.....	.....	.....	846,246	12,425,815
New Jersey	.....	.....	.....	.....	.....	.....	1,410,941	(1)
New York	.....	.....	.....	.....	.....	.....	5,687,225	72,756,957
Ohio	.....	.....	.....	.....	.....	.....	10,562,486	128,843,686
Pennsylvania	11,384	8,906,194	64.38	5,733,835	$67,303,836	$11.74	22,383,524	257,033,715
Tennessee	.....	.....	.....	.....	.....	.....	251,428	(1)
Texas	.....	.....	.....	.....	.....	.....	644,225	(1)
Utah	797	356,982	52.83	188,586	(1)	(1)	1,247,087	(1)
Virginia	750	344,612	58.30	200,911	2,886,723	14.37	200,911	2,886,723
West Virginia	952	550,047	64.08	352,494	4,801,771	13.62	3,650,584	37,892,068
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	195	163,733	62.14	101,745	(1)	(1)	2,374,960	(1)
Undistributed	.....	.....	.....	.....	4,570,441	15.74	.....	139,440,862
Total: 1948	14,078	10,321,568	63.73	6,577,571	79,562,771	12.10	74,861,928	928,281,854
1947	13,443	10,474,536	63.84	6,687,301	65,305,111	9.77	73,445,850	776,405,520

(1) Included with "Undistributed."

of the value of the tar used by the producer and the value of the coke breeze produced) was $267,126,556 or 28.8 per cent of the gross value of the coke produced. The average yield of the primary coke by-products declined in 1948 over 1947. In 1948 the average yield of tar decreased from 7.78 to 7.60 gal per ton of coal; ammonium sulphate or equivalent dropped from 19.66 to 19.52 lb per ton; crude light oil from 2.75 to 2.73 gal per ton; and the average yield of gas dropped from 10.27 to 10.23 M cu ft per ton.

There's only one way to assure heating efficiency—



LOOK INTO

RUST *ZONE-CONTROLLED* CONTINUOUS FURNACES

for reheating blooms, slabs, billets, bars . . .

ONLY ONE TYPE of continuous furnace provides perfect control of the heating operation from start to finish. That's the Rust Zone-Controlled Recuperative Continuous Furnace with independently fired heating and soaking chambers. Built in tandem, they assure control of tonnage output, heating quality and 100% accuracy in control of predetermined heating temperatures.

Roof design at charging end of heating chamber allows for expansion, thus reduces velocity and eliminates bleeding of waste gases. Flexibility of output is achieved by changing rate of fuel fired. Soaking chamber heat remains constant for any specific rolling temperature, gives uniform heat distribution with a minimum of fuel. Consult a Rust expert now on Double and Triple-Fired type furnaces for heating light and heavy sections.

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J. WALTER JOHNSON
BIRMINGHAM DISTRICT SECTION

HARRY H. NORTHRUP
BUFFALO DISTRICT SECTION

C. W. BRUCE
CHICAGO DISTRICT SECTION

AISE DISTRICT CHAIRMEN 1949 - 1950

J. WALTER JOHNSON was born in Chicago, Ill., and a few years later moved to Birmingham, Ala., where he attended public schools, Ensley high school and Auburn University. He was employed by Tennessee Coal, Iron & Railroad Co., Ensley and Fairfield works, as a levelman progressing to construction engineer. In 1935 he was transferred to the Ensley works rail mill as turn foreman, where he became night superintendent of rail mill. He is now assistant superintendent of the bessemer rolling mills, Birmingham.

HARRY H. NORTHRUP was born in Centre County, Pa. and is a graduate of the Pennsylvania State College with the degree of bachelor of science in metallurgy. He joined the Republic Steel Corp. in Youngstown, Ohio in 1935 and worked successively as third, second and first helper and melter in that open hearth department. He transferred to the Buffalo plant of the same company as assistant open hearth superintendent in 1942. He was made superintendent of open hearth of the Buffalo district in 1947.

C. W. BRUCE was graduated from Case Institute of Technology in mechanical engineering in 1933. He started in the steel business in the blooming mill at the Corrigan-McKinney Steel Co., and in 1934 transferred to the combustion department. After the merger with Republic Steel Corp. in 1935 he continued in the combustion department until 1942 at which time he was transferred to the Chicago district of Republic Steel Corp. as combustion engineer. In 1947 he was made assistant chief engineer of the Chicago district.

J. H. FRANZ was born July 10, 1910 in Glenshaw, Pa. and attended Shaler Township, Pa., schools from 1916 to 1926. He graduated from Etna, Pa., high school in 1928, and began to work in April of 1929 for Carnegie Steel Co. as an electrician's helper. From 1929 to 1937, he held various maintenance department jobs, such as electrician's helper, welder, electrical millwright, etc.

He entered Carnegie Institute of Technology night school in 1931 and received a certificate of electrical engineering in 1937, then received a bachelor of science degree in electrical engineering in 1941. In June 1937, he was transferred to the Edgar Thomson works, engineering department as assistant electrical engineer, and in July 1941, was transferred to Carnegie-Illinois Steel Corp. ordnance engineering bureau as chief electrical engineer. He transferred to Youngstown district of Carnegie-Illinois as chief electrical engineer in May 1943. In March 1946, he was made assistant to division superintendent of maintenance of Youngstown district, Carnegie-Illinois.

He was promoted in July 1948 to superintendent of operating maintenance department, Ohio works of Carnegie-Illinois Steel Corp. Since May 1949 he has been superintendent of the fabricating shops of the McDonald mills, Carnegie-Illinois Steel Corp.

WARREN E. HART, a native of Detroit, Mich. and long associated with the Ford Motor Co., Rouge plant accepted his present position as superintendent of the electric furnace building early in the year of 1935. His metallurgical experience has been entirely with the Ford Motor Co.'s foundries, and ingot steel operations. His technical education was obtained through various Michigan Educational Institutions, including the Henry Ford trade school.

W. E. ZELLEY was born at Fieldsboro, N. J. on November 4, 1901, and after completing his high school studies was employed by the Public Service Electric and Gas Co. at their generating station at Burlington, N. J. He studied electrical engineering at the School of Industrial Arts, Trenton, N. J., graduating in 1923. Mr. Zelley was employed by John A. Roebling's Sons Co., June 1923, as an electrician, advancing to the position of assistant general foreman of the electrical departments by September 1933. He was appointed general foreman of electrical departments in June 1940 and advanced to the position of staff engineer, electrical, August 1945, holding that position until January 1947 at which time he was appointed superintendent of maintenance, construction, and utilities at the Roebling, N. J. plant, and he is still in that position.

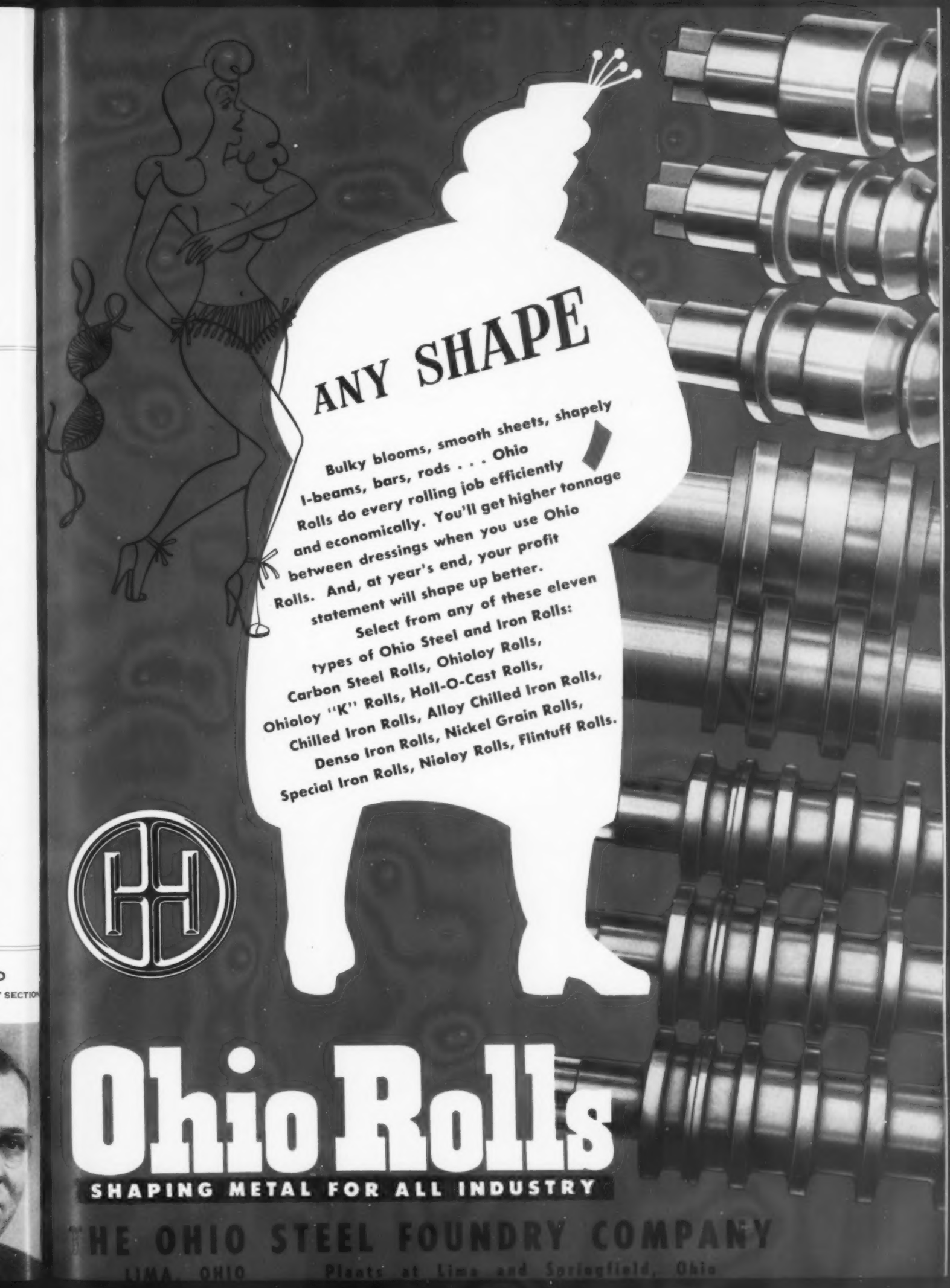
S. C. READ started to work for Jones & Laughlin Steel Corp., Pittsburgh, Pa., in 1924 as assistant superintendent, power department at the South Side works. In 1938 he was made master mechanic of rolling mills, Pittsburgh works. He was appointed superintendent of blooming department and rolling mills, Pittsburgh works in March 1946. In November 1947 he was named manager of maintenance for the entire corporation. Mr. Read attended Purdue University and the University of Michigan, graduating from the latter with a degree in mechanical engineering. He later received a master's degree in metallurgical engineering at Carnegie Institute of Technology.

J. H. FRANZ
LEVELAND DISTRICT SECTION

WARREN E. HART
DETROIT DISTRICT SECTION

W. E. ZELLEY
PHILADELPHIA DISTRICT SECTION

S. C. READ
PITTSBURGH DISTRICT SECTION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THE OHIO STEEL FOUNDRY COMPANY
LIMA, OHIO
Plants at Lima and Springfield, Ohio

Pictorial Review

1

Despite a nation-wide steel strike, the 1949 Convention of the Association of Iron and Steel Engineers was held October 3, 4, 5 and 6, in the Hotel William Penn, Pittsburgh, Pa. The total registration (1) of 1754 exceeded the expectations of the AISE.

2

Each morning at 7:45 a.m., authors and chairmen for the day gathered for breakfast (2) and assured smooth-flowing programs. Authors for electrical (3) and rolling mill (4) sessions were typical of the participating steel mill experts who manned the 12 technical sessions, covering electrical, combustion, rolling mill standardization, mechanical, operating practice and materials handling divisions of the steel industry.

3

The lady guests were entertained (5) by a reception and tea on Monday, October 3, a luncheon on Tuesday, October 4, and a dinner dance on Wednesday, October 5.

The steel strike necessitated cancellation of the two inspection trips, requiring last minute planning as shown in (6) when C. H. Williams, AISE president, conferred with T. J. Ess, AISE managing director. The

4

5

6

1949 AISE CONVENTION

strike, however, did not deter the Old Timers from having their annual get-together (7) where talented members entertained the group.

In addition to the technical sessions, many unscheduled discussions (8) were held. James Farrington, AISE founder, is seen in (9) center, with L. A. Umansky, right, and A. R. Oltrogge, left.

A novel feature was the cheese bar (10) where Mrs. E. F. Kochman spreads cheese for J. S. Sides, left, and J. S. Rashba, right.

The winners of the 1948 AISE John F. Kelly Awards were (11) A. H. Arbogast, E. C. McDonald, and Ross E. Beynon.

Preceding the annual banquet on Wednesday, October 5, a reception was held for speaker's table guests. Seen at the reception (12) were J. H. McElhinney, Wheeling Steel Corp., and W. H Colvin, Jr., Crucible Steel Co. of America. Carl B. Pollock, Allegheny Ludlum Steel Corp., is seen (13) with A. S. Glossbrenner, Youngstown Sheet and Tube Co., who was elected president of the AISE for the year 1950.

10

11

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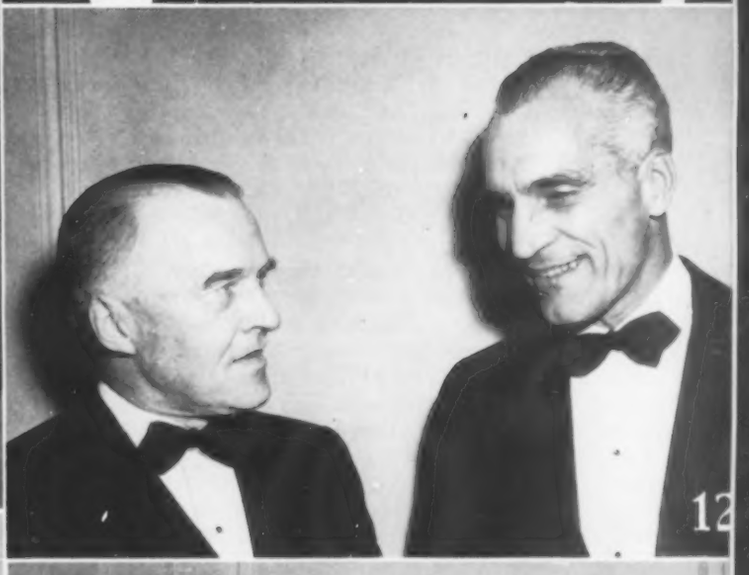
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13

Engineering Responsibility in the Steel Industry

By M. W. REED
Vice President, Engineering
United States Steel Corp.

▲ "TECHNOLOGY, including its engineering phase, is incidentally involved in putting people out of work and destroying property. Its objective is to enable the new and growing needs and desires of the nation to be met with less labor and cost than would otherwise be required. The results are to increase what we call productivity and to make more new jobs than are destroyed. The attainment of this increase in productivity demands, in addition to displacement of labor, the displacement of old properties and their replacement with new and additional properties. We can measure how fast technological progress is being made by noting the frequency with which displacements in labor and properties occur.

"In the United States, engineers worked for many years under conditions that permitted, encouraged and rewarded the most rapid development of scientific and industrial techniques. The result has been the emergence of the United States of America as the dominant nation of the world with its standard of living and the comfort of its people incomparably better than that to be found in any other nation. Today many segments of our people apparently feel that the nation's position is so dominant that we can afford less rapid technological development and a more speedy accomplishment of greater social comfort.

"Beginning about fifteen years ago the rate of technological progress in industry in this country began to decline. The second World War did not help the situation since it required the attention of most everyone to be directed towards the destructive efforts which war requires. In the years since the conclusion of the war the annual increases in the rate of productivity have not compared favorably with earlier conditions. It is true that in the past fifteen years there have been many astonishing and beneficial developments; nevertheless, they have not been adequate to maintain the rate of progress which this nation formerly enjoyed. The nation has fallen behind by an estimated eighty billion dollars worth of new or replaced facilities, and as one result the present annual rate of increase in productivity has been estimated to be from 30 to 50 per cent below what it could have been.

"The question is: 'Why does this situation exist and what is the responsibility of the steel industry engineers in connection with it?'

"A little background may help to paint the picture. The activities of engineers and other technologists have been the subject of argument for hundreds of years. The argument has always revolved around the central theme of the effect of technology in the economy of a nation, and usually when it gets down to its simplest form, it is an argument between those who believe that progress in technology should go ahead as fast as knowledge and the law of supply and demand will permit and those who believe that the social comfort (more frequently called social security) of the people should take precedence over such rapid progress.

"The old argument, possibly couched in different terms, is in full swing today. The activity of engineers and other technical groups are the subject of much attention by social theorists and economists. Technology is being praised for its part in economic progress; it is being accused of causing much unemployment and social discomfort. Technology is being extolled for creating new industries and providing jobs for additional millions and at the same time is criticized for causing much individual suffering and social loss. It is claimed that technology advances so rapidly as to cause fundamental dislocations in the economy of the nation and that additional political or man-made laws are necessary to prevent social harm befalling certain groups of people. At the same time the most rapid progress in technology is recognized as indispensable to national security.

"Whether or not a nation can have everything in social comfort and social security and at the same time avoid a reduction in technological progress and national security is doubtful. It is apparently slowly dawning on England, for example, that partly because her industries fell behind in technological progress compared with other strong nations her standard of living, her social comfort, has fallen. She is finding that the provision of more social comfort, to the extent that it interferes with the stepping up of productivity, causes the standard of living to drop further and further.

"We would agree, of course, that to have the maximum in both social comfort and technological advancement is desirable. But human nature never stands up under the strain! In this practical world there always has been and there always will be some kind of competition at one level or another inside the boundaries of a nation and also competition between nations; and when competition exists there are always those, sometimes more powerful and sometimes less powerful, but always at work, who will sacrifice comfort and risk security for what they believe is in the interest of their own progress. You have seen this sacrifice of comfort on a national basis in every war that has been fought. You see it on group basis when stockholders and a labor union are willing to accept a strike despite the degree of present or future discomfort that may result. You see it on an individual basis in the businessman who works day or night as the conditions require to operate his business successfully.

"I think it safe to conclude that if social comfort is ever afforded precedence over technical progress in the economy of a nation it can so exist only for a temporary

Presented before AISE Annual Convention, Pittsburgh, Pa., October 5, 1949

period. But in such a temporary period a nation may lose its headway in productivity to such a degree as to make it insecure and dependent on others.

"Today in this country the desire for social comfort and security has taken precedence over the desire for technical progress. This is evidenced not by the Trojan horse full of speeches and written articles by many important people, but by some of the laws and results that now confront us.

"Thus the picture is painted and the question is again asked: Why does this condition exist and what is the responsibility of the steel industry engineers in connection with it?

"I suppose the underlying reasons for the existence of this condition are first, the natural desire for security has been stimulated by the sense of insecurity resulting from two world wars even though social security and comfort are not always consistent with national security; and second, the proportion of elderly people in this nation has increased rapidly. These people are in a large proportion of cases ones who have passed the age at which they can work for a living and social security has become very important to them. This increase in the number of elderly people who are not now able to work has been accelerated by the increase in length of life due to improved health conditions and to the increase in proportion of people who are dependent on jobs as employees of others instead of being self employed.

"There is probably nothing that engineers should do to change a normal desire for social comfort but there is probably quite a lot that they can do to influence the keeping alive of the desire for making maximum technological progress. And this I think is the responsibility which steel industry engineers, along with others, have in connection with the existing situation.

"The existence of desire for social comfort in preference to technical progress is evidenced by some of the laws and results that now confront us.

"The laws to which I refer include some that have to do with taxation, some that affect labor unions, some that have to do with finance and banking, and some that have to do with subsidies and bureaucratic controls by government agencies. They are those laws that enable their advocates, by means of economic compulsion, to force adoption of social welfare activities in preference to technological progress.

"Some of the results to which I refer are 30 to 50 per cent slower rate of increase in productivity; an accumulation over fifteen years of about eighty billion dollars deficit in properties and facilities. Those are results that are approximately measurable. Other results which have shown up are the attitudes and actions of some leaders which indicate their belief that the people they represent do not know what is good for them or that what they do not know will not hurt them, and lastly, the increasing number of young men who are placing security and comfort ahead of opportunity in their consideration of their future careers.

"Let us examine some of the ways in which the engineers of the steel industry may help to improve these conditions.

"Consider first the young engineers, those who are still under instruction and those who have recently started out on their first jobs in industry. In far too many places young men are being taught that social security and comfort are preferable to opportunity. The existence of such laws as previously mentioned is used by many advocates as the ground-proof from which to spring that teaching. We find an increasing number of young men who would rather take a job which they think would provide security than one which they might know would provide opportunity.

"Engineers, particularly those in the older group, can do a great deal in connection with this. They can give more time and thought to the training of the young men who join their organizations; they can talk carefully with their sons and young friends; and they can be helpfully critical in guiding the thinking and practical teaching which emanates from the schools and colleges of their interest.

"The younger members of the engineering profession have an even greater responsibility in this matter than the older members because it is from the ranks of the younger men that tomorrow's leaders will be chosen. To be ambitious but not impatient, to understand the lessons of experience and history as compared with rosy promises, to keep an alert, open, reflective mind as compared with blindly following the teachings of others, to understand men and human relations, to seek opportunity and to work well and faithfully are things that cannot be neglected.

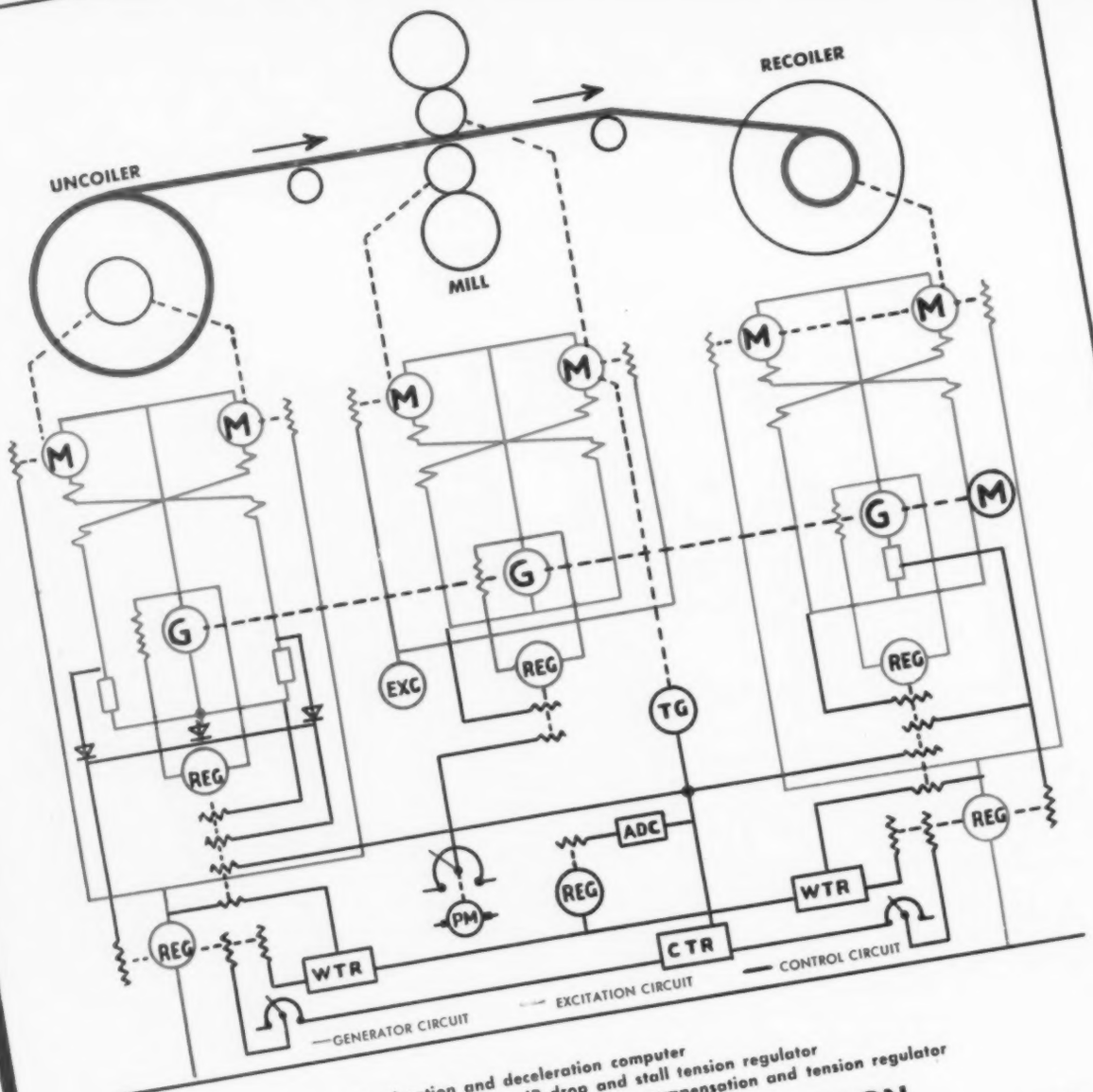
"Another way in which engineers, and possibly engineering organizations such as the Association of Iron and Steel Engineers, may be helpful is through an understanding of proposed laws and existing laws, particularly an understanding of the effect that laws will have or do have on the progress of technology in the economy of the nation. For example: how many of us understand clearly the effect of political manipulation of the currency which is permitted under some existing laws; the effect of double taxation; the effect of inadequate depreciation allowances insofar as they are related to original dollar cost instead of present cost of replacement; the effect of bureaucratic controls; and so on.

"With understanding of these matters the question might then arise as to why should not engineering organizations be as forward in presenting their points of view to the law makers of the country as are labor unions, chambers of commerce, and various lobbies.

"I have not talked about many other responsibilities of the steel industry engineers. Those might well have included discussion relating to supply and quality of raw materials, principally ore and coal; new processes; the influence of electronics and nuclear physics; new plants in keeping with the growth of the nation; and new products which always follow from better and new processes. These are matters which the engineers are going to take care of in their natural stride even though some of the subjects are today posing unusually difficult questions.

"In conclusion then I leave with you these thoughts. The rate of increase of productivity is 30 to 50 per cent below what it could have been due largely to the fact that some laws enacted by Congress, together with over emphasis on social security in relation to technological progress, have caused a lag of some eighty billion dollars in the construction of new and improved properties and facilities in this nation. Technology must continue to be directed at putting some people out of work and destroying property all to the end that there may be an increase in productivity, new products, lower costs, and a steadily mounting number of new jobs. Technological progress must march in advance of social security and comfort if we are to have national security as well as social security in its truest sense. The engineers of the steel industry have a great responsibility —as intelligent, thoughtful members of a great basic industry—to understand the true place of technology in our economy and to helpfully influence the establishment of conditions that will result in the regaining of ground and impetus that has been lost."

CARNEGIE-ILLINOIS STEEL CORPORATION



ADC — Acceleration and deceleration computer
WTR — WR^2 compensation, IR drop and stall tension regulator
CTR — strip speed, friction and windage compensation and tension regulator

SUMMARY OF OPERATION

All operations are performed from an operator's cabinet at each end of the mill. Threading the strip through the single stand mill is accomplished in minimum time. Strip tension between mill and reels is then regulated to any desired value by means of the current regulating exciters of each reel. By proper adjustment of the IR drop, friction-windage and strip speed compensation features, the tension may be held constant as required to provide a uniform quality of the processed strip. Any change in reel motor current and thus the tension, is translated to the regulators which immediately modify the reel motor fields in such a way as to re-establish the tension. Sudden transient requirements of a wider current modification are also translated to the voltage regulators of the reel generators which immediately respond to assist in establishing the desired current. The required change in current and torque when accelerating and decelerating a coil is measured by a WR^2 compensating device which responds to actual rate of change in speed of the mill tachometer generator (TG) and thus insures the proper compensation with any rate of acceleration.

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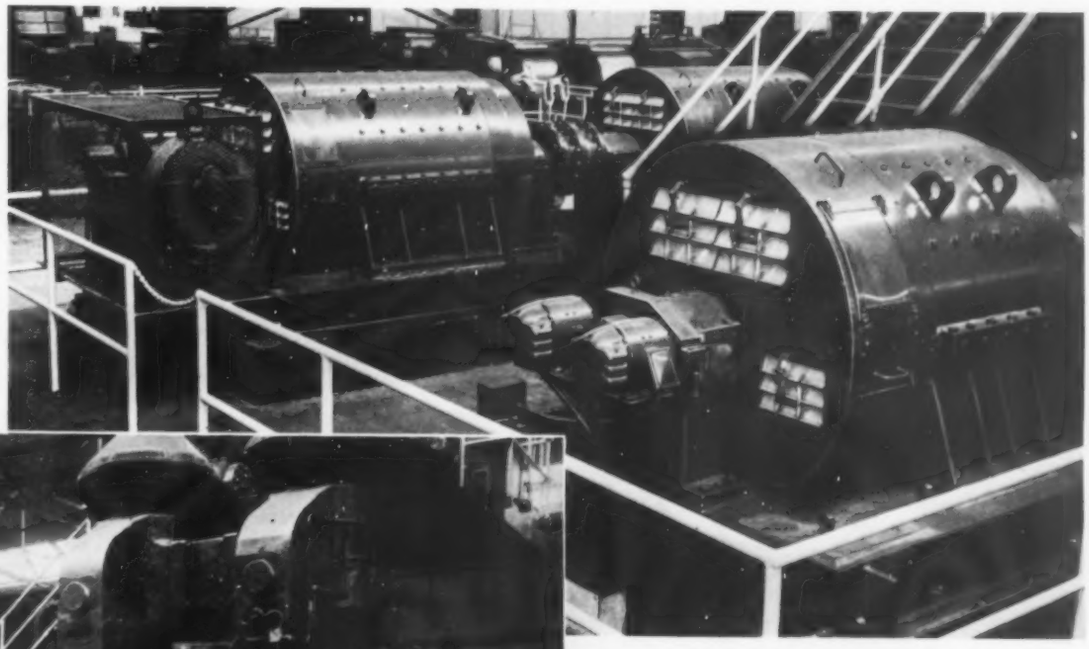
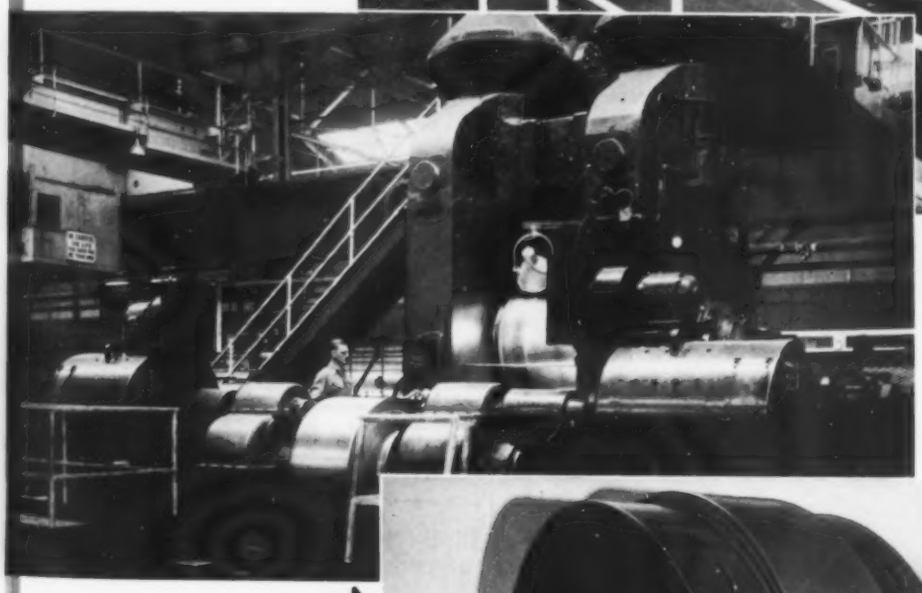
FABRI-STEEL

Motors and Generators

for modernization of No. 3 Temper Pass Mill at Irvin Works. The entire drive was coordinated by Elliott with Cutler-Hammer control and Reliance regulators. Mill speed has been increased from 500 fpm to 2500 fpm, with provision for future increase to 3750 fpm, by gear changes.



At right, one of the two Elliott 600-hp, 450/1000-rpm, enclosed force-ventilated main roll drive motors with two Reliance series-connected control tachometer generators in the foreground. The two tandem-coupled 500-hp, 250/965-rpm recoiler motors in the background.



Entry side of the E. W. Bliss mill, showing the two Elliott 150-kw, 300/1200-rpm uncoiler motors (drag generators), with motor-mounted ventilating equipment.

Photos courtesy Carnegie-Illinois Steel Corporation

This four-unit Elliott 2100-kw motor-generator set provides the adjustable voltage power through three generators for the two drag generators, the two main roll drive motors, and the two recoiler motors.

MF

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GAS TURBINES
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MOTORS
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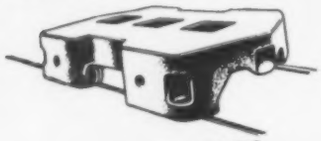
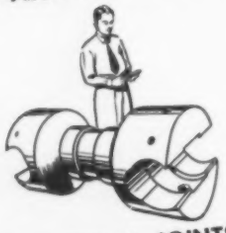


INGOT CARS

CHARGING BOXES

PEELS

SLAG AND CINDER POTS



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Blast Furnace Bells as made by "Union" have proved their economy in major steel plants by wearing *on* when others wore *out*. The metals employed, the casting technique and our complete machining facilities assure you of a gas-tight bell-and-hopper seal plus special hardening treatment that resists abrasion to the limit . . . When it's time to reline—specify Union Hoppers and Bells made exactly to your specifications.

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Send for information on reduction gear drives, pinion stands or combination units for specific applications. Or if you prefer, our engineers will be glad to discuss gear drive problems with you at any time, without obligation.

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- Horsepower
- Input Speed
- Output Speed
- Type of Metal to be Rolled
- Gauge of Metal
- Process (Hot or Cold)
- Nature of Load (Continuous or Intermittent)
- Type of Drive Motor
- Housing:
  - Cast Steel
  - Meehanite® Metal
  - Welded Steel
  - Double Walled
  - Single Walled
- Gears:
  - Continuous-tooth Herringbone
  - Single Helical
  - Combination
- Bearings:
  - Babbitt-lined Steel Cartridges
  - Antifriction
- Lubrication:
  - Dip-and-Splash System
  - Built-in Pump
  - Separate Lubrication System

FB-557

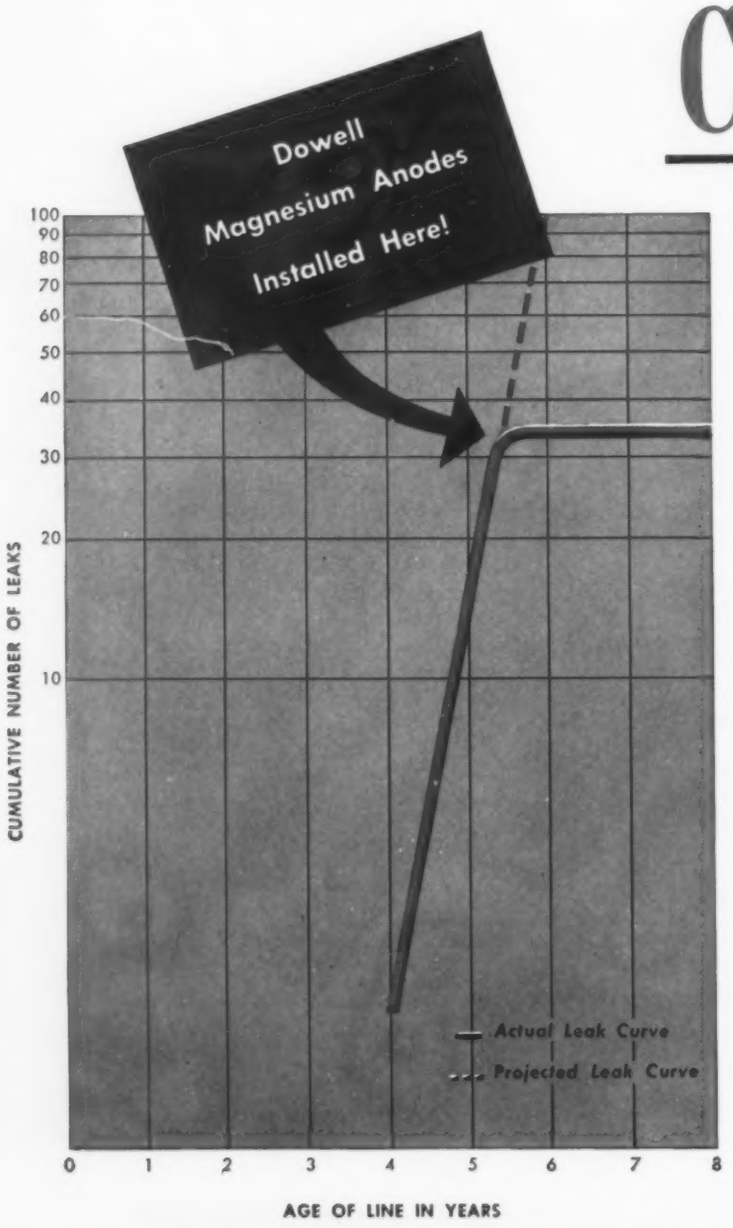
FARREL-BIRMINGHAM COMPANY, INC. • ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

Farrel-Birmingham®

Here's How . . .

PIPELINE MAINTENANCE COSTS CAN BE CUT!



One way to lower pipeline maintenance costs is to reduce the number of leaks. The graph at left shows how a Gulf Coast city cut leaks in a 27 block, 2″ galvanized piping system. The system was installed in 1940 and 1941. By April, 1946, leaks were appearing at an accelerated rate. *Then, magnesium anodes were installed!* Result: 2 leaks in the 30 days following installation and *no new leaks for the balance of 1946, 1947 and 1948!*

Cost-cutting protection such as this is being achieved with Dowell magnesium anodes. When corrosion of buried metal structures is a problem . . . for example, on oil and gas pipelines or municipal distribution systems . . . Dowell anodes may afford practical, economical corrosion control. The degree of protection will depend on soil conditions and the number of anodes used. Dowell magnesium anodes require no external power and maintenance is at a minimum.

Dowell anodes are carefully alloyed to specifications designed for peak efficiency and long life. The development of these anodes was pioneered by The Dow Chemical Company. Now, Dowell . . . a Dow Subsidiary . . . is carrying on the marketing, research and further development of magnesium anodes. Dowell can give you the technical advice to make your anode installation effective and economical. Write to Dowell for a new book containing detailed information on the uses and installation of Dowell Magnesium Anodes.

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TULSA 3, OKLAHOMA

FREE SHOWING! Now available—a new 18-minute sound slide film illustrating the possibilities of Dowell magnesium anodes for corrosion control. A Dowell representative will gladly arrange a special showing at your plant, office or organization meeting. Call or write Dowell.

DOWELL

MAGNESIUM ANODES

GALVO-PAK • GALVO-LINE

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

September 1

▲ According to the Department of Commerce, the iron and steel industry paid out $32,000,000 more in dividends in the second quarter of 1949 than it did in the same period in 1948. The automobile and oil industry also reported larger dividends for the same period.

▲ The Carnegie-Illinois Steel Corp. put another blast furnace in operation in the Youngstown area thus making five of its furnaces active in that area. Seventeen of the twenty-five in that district are in operation in that area.

September 2

▲ Association of American Railroads stated that shipments of consumer goods last week were highest for any week this year. Total freight loadings were 746,912 cars or off 16.2 per cent from one year ago.

▲ A steel company in the Pittsburgh area purchased some scrap at $25.00 a ton which is a $4.00 per ton increase over the previous similar transaction.

▲ Two mid-western producers raised the prices of zinc ½¢ to 10½¢ a lb.

▲ The Chevrolet division of the General Motors Corp. assembled 163,364 cars and trucks in August for a new record.

▲ Charles M. White, president of Republic Steel Corp., reported that there has been a noticeable increase in demand for steel in August over July which is perhaps due to forward buying because of the labor situation.

▲ Production of iron and steel at the Ohio Works of the Carnegie-Illinois Steel Corp. is being disrupted by a strike of crews on the diesel-electric switching locomotives.

September 3

▲ Republic Steel Corporation announced that all iron and steel making operations at its Massillon, Ohio plant will be shut down today.

▲ Department of Labor reported the continuation of the downward trend in lay-offs and new claims for unemployment for last week were down to 251,000, or the lowest number since late November.

September 4

▲ The Borg-Warner Corp. sold its Superior Sheet Steel Division at Canton, Ohio to Louis Berkman Co., Steubenville, Ohio.

September 5

▲ The Commerce Department reported that new construction put in place in August was 3 per cent above the previous month but 2 per cent under August 1948. The total amount was $1,900,000,000.

▲ Senator O'Mahoney (Democrat, Wyoming) reported that road repairs and construction needed in thirty-four states amounts to $20,000,000,000.

September 6

▲ Based on reports of companies having 94 per cent of steel capacity for the industry, the operating rate of the steel industry is scheduled at 84.2 per cent of capacity for the week beginning September 6, 1949. This is equivalent to 1,552,200 tons compared with 1,591,000 tons scheduled one week ago.

▲ The Elliott Co. announced the purchase today of the Crocker-Wheeler Electric Manufacturing Division from the Joshua Hendy Corp.

September 7

▲ The American and British zones of Germany set a post war record by producing 816,766 tons of steel in August.

▲ The Census Bureau reported that employment went over the 60,000,000 figure in August, and for the first time this year unemployment dropped to 3,500,000 from the 4,100,000 in July.

September 8

▲ American Railway Car Institute announced that freight car deliveries in August were 7,178 cars. Total orders were 185, and the backlog as of September 1st is 28,731. The backlog one year ago was 117,815.

September 9

▲ The Department of Agriculture announced that the estimated cotton crop in 1949 is 14,943,000 bales. This compares with 1948 production of 14,868,000.

▲ Commerce Department said that total inventories of United States business firms decreased about $1,100,000,000 in July.

September 10

▲ President Truman asked the unions and operators to continue working until September 25, 1949, in order to study the Fact Finding Board's recommendations.

September 11

▲ The Steel Fact Finding Board recommended to President Truman that the steel workers withdraw demands for wage boosts and that the companies and union should negotiate a system of non-contributory pensions and social security, which would cost about a total of 10¢ per hour for each worker.

September 12

▲ Based on reports of companies having 94 per cent of capacity for the steel industry, the operating rate of the steel industry is scheduled to be 80.4 per cent of capacity for the week beginning September 12, 1949. This is equivalent to 1,482,200 tons of steel ingots and castings for the entire industry compared with 1,552,200 tons one week ago.

▲ The executive board and Wage Policy Committee agreed to postpone the strike deadline until September 25th.

September 13

▲ Benjamin F. Fairless, president United States Steel Corp., wired Phillip Murray that his company was ready to resume collective bargaining at any time that was mutually convenient.

September 14

▲ Phillip Murray telegraphed the steel companies that his union would not meet with them until the companies accepted the recommendations of the Presidential Steel Fact Finding Board.

▲ Benjamin F. Fairless, president of United States Steel Corp., announced that they are willing to bargain with the union and that also they did not agree before hand to the recommendations of the fact finding board. Mr. Fairless further stated that they were willing to pay up to 4¢ an hour as its share of a social insurance program on a contributory basis, and he also stated that as a matter of sound principle any program of social insurance should be on a contributory basis.

▲ Refined copper deliveries during August rose to 90,739 tons which is about double the July total.

▲ According to the American Iron and Steel Institute, average hourly earnings for the steel industry during July rose to $1.699 compared with $1.684 in June. Estimated total employment in July was 609,600, and total employment in the first seven months of this year was 639,000 persons. Wage earners' hours in July were 31.8 compared with 37.6 in June.

September 15

▲ The Esso Standard Oil Co. is raising prices of No. 6 heavy fuel oil by 20c a bbl at all Atlantic Coast points.

▲ No. 1 heavy melting scrap sold today in Pittsburgh at $30.00 a ton, up $5.00 from the previous purchase.

September 16

▲ According to Ward's automotive report, production of cars and trucks in the United States and Canada rose to an estimated 154,330 units this week from last week's revised figure of 123,806.

▲ Cyrus Ching invited steel producers and the CIO United Steel Workers Union to come to a mediation meeting in Washington on September 19th.

September 18

▲ Great Britain devalued the pound sterling from $4.03 to $2.80, or a cut of 30.5 per cent. A number of other countries are following suit.

▲ The Societe Lorraine des Acieries de Rombas will install a new electric driven blooming mill to replace two obsolete steam units. Modernization project will cost $8,709,000.

September 19

▲ Based on reports of companies having 94 per cent of capacity for the industry, the operating rate of the steel industry is scheduled at 86.2 per cent of capacity for the week beginning September 19, 1949. This is equivalent to 1,589,100 tons of steel ingots and castings compared with 1,596,500 tons one week ago.

▲ According to the F. W. Dodge Corp., contracts awarded by private owners in the thirty-seven states east of the Rockies in August turned upward to a figure of $589,339,000.

▲ John L. Lewis, United Mine Workers president, went on a no-day work week, and as he also put it on a no pension—no work stoppage.

▲ Seventeen countries followed Great Britain's action in devaluing the pound sterling and announced devaluation of their currencies.

▲ Phillip Murray stated that the steel strike would get under way early Sunday unless the industry agrees to the pension insurance plan recommended by President Truman's Steel Fact Finding Board.

September 20

▲ Copper, lead and zinc prices were marked up 10 per cent by Canadian producers to offset the 10 per cent cut in the value of Canadian currency.

▲ According to the Lake Superior Iron Ore Association, August consumption totaled 5,711,208 tons compared with 5,258,321 tons in July. Stocks of iron ore at furnaces and lower Great Lakes Docks amounted to 40,811,232 tons on September 1st.

September 21

▲ President Truman asked for a six day extension of the Saturday midnight steel strike deadline of September 25.

▲ Benjamin Fairless, president United States Steel Corp., wired President Truman that they were willing to continue collective bargaining sessions and approved the continuance of operations.

▲ Railroad companies have over estimated the cost of the shorter work week for the non-operating employees according to R. E. Connolly, vice president of the Illinois Central.

September 22

▲ Harry L. Erlicher, vice president in charge of purchasing, stated that a steel strike would cripple operations of the General Electric Company in three or four weeks.

▲ The CIO Steel Workers put off until October 1st the strike set for September 25.

▲ Canadian Railroad's were granted an 8 per cent freight rate increase.

▲ Freight car loadings for the week ending September 17th totaled 743,022 cars. This was 166,967 cars below the same 1948 period.

September 23

▲ Interstate Commerce Commission authorized a merger of the Pittsburgh, Bessemer and Lake Erie Railroad Co., the Meadville, Conneaut Lake and Linesville Railroad Co., and the Bessemer and Lake Erie Co. The three companies which are subsidiaries of the United States Steel Corp. will be consolidated under the name of the Bessemer and Lake Erie Railroad Co.

September 24

▲ Steel producers and the CIO United Steel Works resumed contract talks.

▲ According to Ward's automotive reports, automobile sales are showing signs of faltering.

September 26

▲ The British Ministry of Supply made tin prices cheaper in the United States and more expensive in Great Britain. The new price is 95¢ a lb in New York, a decrease of 8¢ and the price in England is 93¾¢ a lb, an increase of 22⅝¢.

▲ Department of Commerce announced that foreign aid granted by the United States in the fiscal year ending June 30 totaled $5,169,000,000.

▲ The Commodity Credit Corp.'s annual report stated that farm commodities worth $3,400,000,000 received government price supports in the fiscal year ending June 30.

▲ Based on reports of companies having 94 per cent of steel capacity of the industry, the operating rate is scheduled to be 84.6 per cent of capacity for the week beginning September 24, 1949. This is equivalent to 1,559,600 tons of steel ingots and castings for the entire industry, compared to 1,589,100 tons one week ago.

September 27

▲ According to the American Institute of Steel Construction total shipments of fabricated structural steel for the month of August totaled 172,165 tons compared with 176,306 tons in 1948. Bookings for the month totaled 97,503 tons and the backlog now stands at 582,798 tons.

▲ The CIO Steel Workers formally demanded, retroactive to last July 16th, establishment of pension and social insurance funds as their price for calling off the strike at 12:01 Saturday.

▲ Department of Labor reported that industrial employment increased 500,000 between July 15th and August 15th.

September 28

▲ United States Steel Corp. offered a jointly financed pension and social insurance program, in which U. S. Steel would pay as its share an average of 4¢ an hour for insurance and 6¢ an hour for pensions. The CIO steel workers rejected this proposal.

▲ The R.F.C. cut the price of tin to United States consumers to 96¢ a lb from $1.03 a lb.

▲ According to the Department of Commerce, manufacturers' sales climbed to $17,200,000,000 in August which is $2,200,000,000 above July and the highest level since March.

September 29

▲ Steel producers started to close down furnaces in preparation for the steel strike.

▲ The Ford Motor Co. granted the CIO Auto Workers a pension plan which will cost 8¾¢ per hour per employee.

September 30

▲ Association of American Railroads announced that Class 1 railroads installed 1,296 locomotives in the first eight months of 1949 for the largest sum in any similar period since 1923. Also in the same period, 66,564 new freight cars were put into service.

▲ The Chicago, Rock Island and Pacific Railroad told the Interstate Commerce Commission that it would like to cut rates on iron and steel products to meet truck competition.

▲ The A. O. Smith Corp. announced that it will build a new pipe mill in Houston, Texas which will produce welded casing and line pipe from 8⅝ in. in diam. The mill will have a capacity of 30,000 to 35,000 tons a month making it the second largest welded pipe mill in the world and will cost $5,000,000.

▲ The steel strike started at midnight tonight. Practically all of the larger producers were closed down by the strike.

yes... an oil seal that's tailor-made to *resist* corrosion

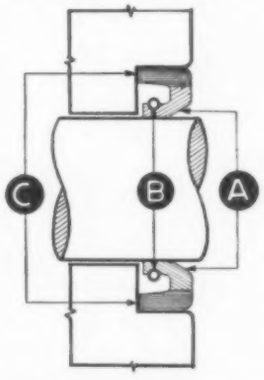
● If corrosive conditions are shortening the life of your oil seals, the Johns-Manville Clipper Seal should provide a practical solution to your problem.

Here's why: The Clipper Seal's molded body is entirely non-metallic and is, therefore, unaffected by most forms of corrosion. To meet special conditions, the garter spring which holds the lip in contact with the shaft can be furnished in various corrosion-resistant metals . . . *or Clipper Seals of special design that do not require garter springs may be used.*

The one-piece, concentric molded design of Clipper Seals also assures a number of other advantages. The hard, tough outer heel of the Clipper Seal is resilient enough to conform even to a slightly out-of-round cavity. And the soft, pliable inner lip always maintains a light, but positive sealing pressure on the shaft, with minimum wear on the seal.

Clipper Seals are quick and easy to install, may be had in split or endless types, are available in sizes from ¼″ I.D. up to 66″ O.D. If you have a special sealing requirement, or wish to consult about a special design problem, write Johns-Manville, Box 290, New York 16, N. Y.

Here's how *Clipper Seal* works:



The flexible lip (A) is held in light but firm contact with the shaft by means of the garter spring (B). Pressure on shaft is carefully pre-determined to minimize wear, yet effectively seal against leakage. The rigid heel (C) provides a press fit in the cavity, assuring a tight lubricant-retaining seal at this point also.

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This unusual application proves the extra margin of moisture protection built into every Ohio Magnet.

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SELECT YOUR MAGNET from two Ohio types. The PROTECTO-WELD magnet, shown here, is made in 39, 46, 55 and 65-inch diameters. Bolted construction types include these and other smaller sizes.

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Ohio MAGNETS

A-1924

Industry News...

ELLIOTT CO. ACQUIRES BUSINESS AND ASSETS OF CROCKER-WHEELER ELECTRIC MANUFACTURING CO.

▲ The acquisition, by Elliott Co., as of September 16, of the business and assets of the Crocker-Wheeler division of Joshua Hendy Corp. has been announced by Grant B. Shipley, chairman of the board of the Elliott Co., Jeannette, Pa.

Elliott Co., whose president is W. A. Elliott, was organized in 1901 and is now a leading builder of steam, power, and electric equipment for process plants. Elliott plants are located at Jeannette, Pa., Ridgway, Pa., Springfield, Ohio, and Newark, N. J. The Ridgway division manufactures large electric motors and generators, and is an outstanding supplier of submarine propulsion equipment and rotating machinery for large electric generating stations.

With the addition of the Crocker-Wheeler division, Elliott Co. now has a complete line of a-c and d-c motors ranging in size from one horsepower up to 25,000 hp. Formerly the Elliott Co. line of equipment did not include motors under 200 hp.

Crocker-Wheeler is one of the oldest manufacturers of motors and generators. It dates back to the C & C Electric Motor Co. founded in New York City in 1885. The Crocker-Wheeler Electric Motor Co. was organized in 1888 and incorporated the following year. In 1893 operations were moved to the site in Ampere, N. J. where the plant is presently located. The company has a well-earned reputation as one of the important pioneer manufacturers of electrical machinery. It pioneered in the electrification of the steel, printing, and other industries. Crocker-Wheeler developed the first auxiliary mill motor for use by the steel industry. It assisted in revolutionary changes in telephone, telegraph, and motion picture industries, and supplied the first motors to operate sewing machines, church organs, exhaust fans, and pumps. It was the first to place the open slot armature on the market, to supply motors geared to machine tools. Its present-day complete line includes types of motors and generators for almost all purposes in every industry. The Crocker-Wheeler plant embraces approximately 14 acres and employs around 1000 people. New buildings have been erected in 1942 and 1945, and other modernization projects completed.

The Crocker-Wheeler division of Elliott Co. will continue to operate under its previous management with Charles A. Butcher as general manager. Mr. Butcher has also been elected a vice president of Elliott Co.

Shown below is an aerial view of the Crocker-Wheeler plant at Ampere, N. J.

GEIGER COUNTER USED TO ANALYZE STEEL

▲ The Geiger counter, famed for its ability to detect uranium and other radioactive materials, and also as an aid to nuclear physicists in atom-smashing development, has found a new and extremely useful job in the steel industry.

It has been adapted by scientists of the research laboratory, United States Steel Corp. of Delaware, to the development of a quick and accurate method of analyzing steel samples. After careful calibration for many specific problems, many of which are yet to be solved, Geiger counter analysis is expected to be even faster than the direct-reading spectrograph, which is itself a recent development in metallurgical analysis. In the laboratory studies, it is used in conjunction with special spectrographic equipment and has achieved a measure of success in revealing quickly the kind and quantity of alloying elements in steel.

This does not mean that the chemical elements which are combined with iron to make steel are radioactive, as might be inferred from the Geiger counter's more celebrated job. As it is capable of detecting and measuring radioactivity, this remarkable instrument is capable also of measuring invisible fluorescent rays, each of a special kind, that emanate from a steel sample when its atoms are ionized by powerful X-ray.

In many ways it is really simpler to make a Geiger counter analysis than an ordinary chemical or a spectrographic analysis of steel. Almost any piece of steel that has a flat surface will do for the purpose, so long as it is reasonably clean. Thus

HERE'S A 40% CUT IN REFUSE DISPOSAL COSTS

Savings range from $20,000 to $200,000 per year

High labor costs, loss of operating time, haulage waste and expensive maintenance in your refuse disposal operation can be cut as much as 40%.

These great savings are realized through the use of big, tough Magor Automatic Air Dump Cars; cars designed specifically for steel plant service.

That's the answer – built specifically for steel plant service.

Today, a good many plants—large and small—use gondola, hopper or old type dump cars which were not designed to take the rough treatment unavoidable in refuse disposal operations. Therefore, maintenance, repair and labor costs have climbed tremendously—adding a staggering sum to the normal expenses incurred in such service.

A cost analysis survey made by Magor Engineers can determine the actual cost of your refuse disposal operations. They can show you, on the scene, how Magor Automatic Air Dump Cars can cut those costs.

Write today for complete information. There's no obligation, of course.

• A 30 yd. 70 ton Magor Heavy Duty Automatic Air Dump Car costs only $1.35 per day to own.

When writing, be sure to request your copy of the New Magor Air Dump Car Brochure. It shows how these modern steel plant cars can save you money.

MAGOR

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World's Largest Producer of Air Dump Cars

analysis might be made of a random section of steel rail, the bottom of a cooking pot, a knife blade, or a flattened mass of steel file dust.

"It has long been known that chemical analysis is possible from fluorescent or secondary X-rays," explained Dr. James B. Austin, director of research and head of the United States Steel laboratory, Kearny, N. J. "In principle, a specimen may be bombarded with electrons or X-rays strong enough to ionize the various atoms; the process of electronic rearrangement of these atoms gives rise to X-rays which are characteristic of the several elements present in the specimen. Measurement of the quantities of the various rays emitted is a short-cut to chemical analysis.

"Work in this field has been handicapped by the lack of intense X-ray sources and the necessity in the past of measuring the intensities of the rays by the blackening of photographic film. Even with crude equipment, however, it has been possible to detect elements of middle-atomic weight in quantities as low as one-hundredth of 1 per cent of the specimen being studied. To accomplish this it was necessary to mount the specimen directly on the target of an X-ray tube, to use film exposures over many hours, and rigidly to control film processing and density measurement. With the advent of stronger X-ray tubes and the Geiger counter, this type of fluorescence analysis has become relatively simple and much more useful."

A 20-milliampere, 50-kilovolt, molybdenum target X-ray tube is used in the United States Steel laboratory studies. The ray floods the steel specimen, exciting secondary rays which are characteristic of the chemical elements alloyed with iron in the sample. These fluorescent rays are reflected through a narrow slit at right angles to the path of the primary X-ray to a crystal monochromator. This crystal is in the center of a circle one-fourth of whose circumference is transversed by the Geiger counter in its round of analysis. The counter is moved by motor in this scanning operation.

MEEHANITE METAL REPRESENTATIVES TO MEET

▲ Representatives of all the manufacturers of Meehanite castings in the United States and Canada will convene in the annual Meehanite research meeting, at the Hotel Carter, Cleveland, Ohio, November 2-5.

Some two dozen researches conducted during the past year on all phases of foundry activity, including production, management and sales, will be presented to an expected attendance of over 200.

BUDD CO. BUILDS CASTINGS PLANT

▲ A modern foundry will be erected at Philadelphia, Pa., by Budd Co. at a cost of approximately $1,500,000, it was announced recently. The new plant will furnish grey iron castings for other divisions of the company, so that Budd can better serve its automotive customers, particularly those who have Eastern assembly plants.

The new structure will be located in Northeast Philadelphia. It will be a 120 x 360 ft, one-story brick building. It is estimated that between 400 and 500 workers will be employed after the new plant has gone into production.

The foundry will be modern in every respect. Every device required to provide ideal working conditions will be included. The best dust ar-

For Improved Drawing and Longer Die Life

Copper-coat WIRE, ROD and TUBING with

Cuprodine®

"Cuprodine", in a simple chemical process without current, deposits an adherent layer of copper on both mild and stainless steels. This layer acts as an effective lubricant—reduces wear and scratching of dies; prolongs die life; minimizes scratching on wire, rod and tubing; and increases the number of draws per die.

"Cuprotek"® passivates Cuprodized and other cuprous surfaces, and acts as a paint bond, or a good temporary preventive of corrosion.

Write or call Ambler 0486, for further information on both "Cuprodine" and "Cuprotek".

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Experience looms large

in building conveying equipment for moving HEAVY COILS

Experience is a general term which can mean most anything. But you know what experience means to an open hearth first helper or an operator on the continuous strip mill. It is the factor which makes the big difference.

Now consider the conveying equipment which moves heavy coils. Only experienced designers know what weights and what designs are required to stand up under the terrific, continuous pounding. Mathews' engineers have devoted many years to designing conveyers for moving coils—experience that dates back to the days of the lightweights and through the heavyweights of today. It is this experience that helps steel plant engineers to do a better job.

Mathews' engineers are specialists in steel and brass mill conveying equipment. So, keep this in mind when you have problems involving the handling of heavy loads.

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
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CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

Engineering Offices or Sales Agencies in Principal American and Canadian Cities

resters and smoke consumers will be installed.

Ground will be broken this month and the first unit is expected to be in operation next spring.

Budd is now operating its Detroit foundry at full capacity. The new Philadelphia foundry will ultimately double the company's capacity for grey iron castings.

RELIANCE EXTENDS EUROPEAN SERVICE

▲ Extension of application engineering services to European users of its electric motor drives and related equipment is announced by Reliance Electric & Engineering Co., with the dispatch abroad of Clarence J. Marx to establish headquarters for such technical services in England.

"Immediate responsibilities of Marx," said E. E. Helm, Reliance sales vice president, "will be to supervise the 'tune-up' of Reliance equipment on projects now going into operation in England, France, Sweden, Austria, Italy and Belgium. In addition, he will be available to assist foreign representatives of American machinery manufacturers who have electrical equipment problems to be solved.

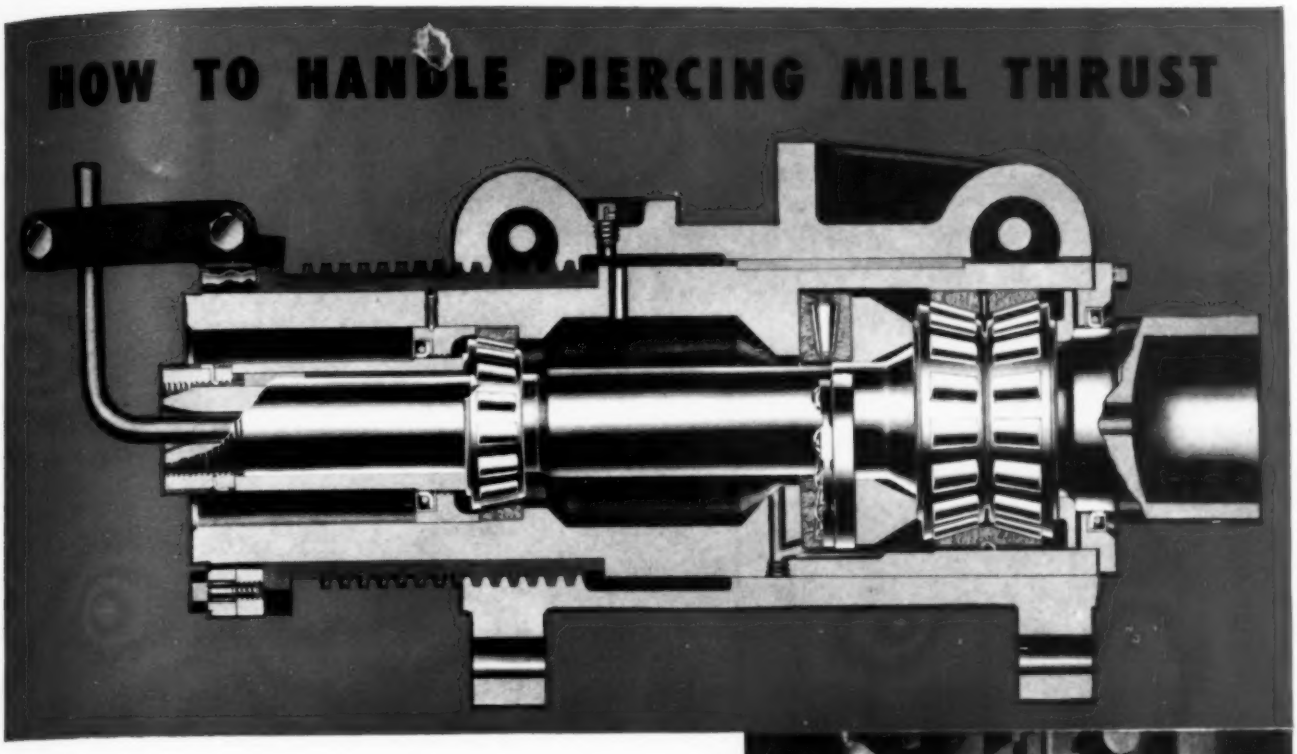
"Work already scheduled for Marx includes installations in the steel, paper, textile and rubber industries and machine tool applications in a score of other fields."

A Clevelander from birth, Marx worked in the drafting department of Reliance for the better part of six years before enrolling in electrical engineering at Ohio State University. Upon graduation in 1939, he returned to Reliance as a design engineer; subsequently spent nine months in the army before transferring to the navy, where in a civilian capacity he served in the Bureau of Ships for 2½ years. Since 1944 he has been a senior product engineer with Reliance.

COAL FOR SINTERING TO BE MADE AVAILABLE

▲ The Pittsburgh Mill Steel Co., Inc. announced the formation of a new department to be known as the coal division.

Alice G. Hansen, president, stated that the corporation has acquired exclusive sales franchises from coal producers in the Pittsburgh and West



WITHOUT FRICTION AND LOSS OF SPEED

Zooming from zero to 1,200 R.P.M. is a matter of split seconds with Timken bearing equipped piercing mill thrust blocks. There's no sluggishness as with plain bearing blocks.

Timken bearings help piercing mill thrust blocks perform steadily with minimum maintenance because friction and wear are eliminated; thrust, radial and combined loads are kept under complete and constant control; lubrication is simplified; and thrust block rigidity greatly increased.

Practically every seamless tube manufacturer in the country uses Timken bearing equipped piercing mill thrust blocks. Do you? Write for specific information covering your requirements.

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TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

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NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ⟷ AND THRUST ⟷ LOADS OR ANY COMBINATION ✳

Virginia area. The coal in these regions is well known for its properties in sintering processes and much of it is used for steam purposes.

Paul V. Forte, Philadelphia, well known in the Pennsylvania anthracite fields, has been retained as a consultant in the purchasing division. He has had a long and varied background in the coal business and has acted as a consultant to several large coal firms.

The Pittsburgh Mill Steel Co., Inc. is presently negotiating for the acquisition of several coal producing properties in both the anthracite and bituminous areas. It will shortly announce to the trade availability of coal from these mines when negotiations have been completed.

ROLLING MILLS FOR AUSTRIAN STEEL FIRM

▲ Lewis Foundry & Machine division of Blaw-Knox Co. recently executed its first large postwar order from Austria for modern rolling mill machinery. The last shipment on this order sailed from New York harbor September 8 on the S. S. Algonquin Victory.

The contract involved approximately $1,000,000 and was placed under the provisions of the Economic Cooperation Administration. The order was placed by the Austrian firm, Osterreichische Metallwerke Aktiengesellschaft. It covered the design and manufacture of four cold rolling mills and auxiliaries, to be installed at Vienna.

Included are two skin pass mills for rolling steel strip; one strip roughing mill for rolling sheet and strip aluminum; and one mill for rolling aluminum foil. All the units are relatively new to European industry and it is expected that this export market for rolling mill machinery will grow once the rehabilitated countries become familiar with American postwar developments and improvements.

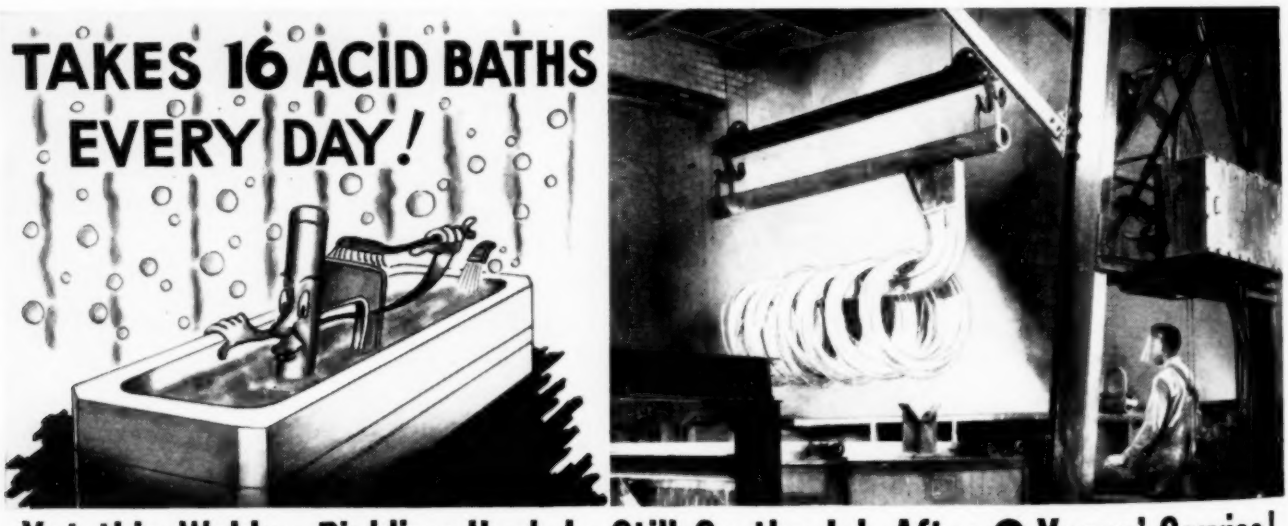
The largest unit in the group is the strip roughing mill, a four-high mill 15 by 36 by 60 in. This mill embodies the principles of a new four-high single stand design recently introduced by Lewis Foundry & Machine.

The foil mill is the first mill of this type supplied to Europe by Lewis, which has long specialized in the development of aluminum foil mills and has placed more than 50 such units in American service. The foil mill is also a four-high unit, 9 by 21 by 44 in., which is a very popular size in the United States. This mill will roll widths up to 36 in. with a finished gage of .00035 in. (3½ ten-thousandths of an inch).

The two skin pass mills are two-high units, 22 by 50 in. Many similar units are in U. S. service in both steel and non-ferrous plants. However, skin pass mills are not yet commonly used in the European metal industries and a continuing future market for this type of equipment is visualized. Among the modern refinements on the units in this shipment is the integration of the coil loading and unloading mechanism into a packaged unit that can be conveniently removed for servicing.

COAL RESEARCH LAB BUILT BY McNALLY

▲ McNally Pittsburgh Manufacturing Corp. has started construction of



Yet this Weldco Pickling Hook Is Still On the Job After 3 Years' Service!

Installed in the Lamson & Sessions rod and wire mill in November, 1946, this lightweight hairpin hook is still going strong—in spite of continuous loading, pickling, liming and washing operations. This rigorous work goes on day after day, yet the Weldco hook stays right on the job . . . shows very little corrosion from the daily baths of hot 5% sulphuric acid solution. And thanks to its high strength, the hook carries payloads of 3000 pounds!

Weldco lightweight hairpin hooks will show an excellent service record in your plant, too. Why not find out today how they can improve your pickling operations and cut costs?

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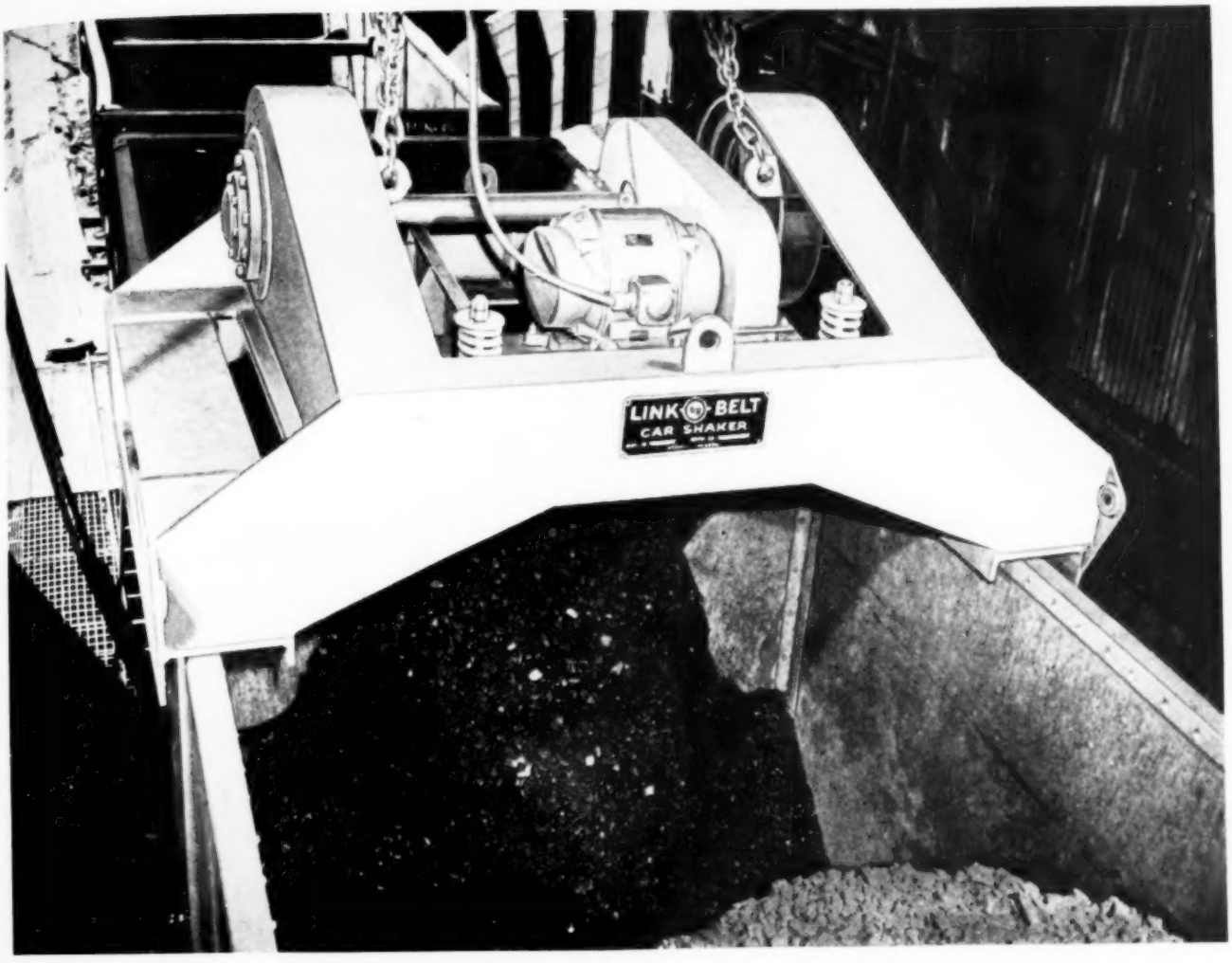

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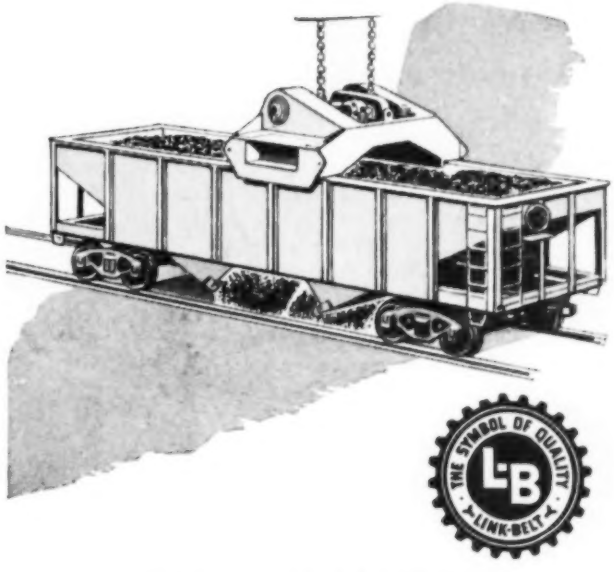
LINK-BELT CAR SHAKER

Lower the Link-Belt Car Shaker to the top of the car walls. Start the motor which delivers vibrations to the car sides and sloping hopper bottoms, loosening the material for easy "broom-clean" unloading in minutes. Reduce unloading costs and injury hazards and eliminate demurrage charges with this efficient unit. It is especially valuable for unloading damp or frozen materials. May we send you full information? Send for Book No. 2345.



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Service proved for all steel mill requirements

● The view at the left above shows Quick-As-Wink Valves operating the pallet conveyor tilter, mandrel type feed reel carriage, and lowering and raising elevator on a 3/16" x 68" hot mill rotary flying shear. View at the upper right shows two 3-way Quick-As-Wink valves for a 56" rotary shear hydraulic piler. The view at the lower right above shows the control for a pallet conveyor tilter, feed reel hoist, and clamping mechanism on a 68" 2-high skin pass mill.

Other Quick-As-Wink valves are being used on run-out tables, mill stands, coilers and a wide variety of other steel mill equipment.

Furnished in hand and pilot cylinder operated designs for every industrial application. Let us quote on your requirements.

Quick-As-Wink Lever Operated Hydraulic Valves

The HS-551-N4 pictured above is a neutral position 4-way valve for controlling double acting cylinders. It has a machined steel housing, chrome plated and polished stainless steel plungers, and renewable metal rings to take the impingement of the liquid flow preventing wear on the U-packers. Used for oil or water up to 3500 P.S.I. and 150° F. Other valves available for pressures up to 5000 P.S.I.;—but send for a catalog today and get *full* details about the *complete* line.

Quick-As-Wink Control Valves

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Manufactured by **C. B. HUNT & SON, Inc.,** *Salem, Ohio.*

Engineering and Sales Representatives in the Principal Cities

a new coal research laboratory building at Pittsburg, Kan. When completed in November, it will add 4500 sq ft to current floor space.

The company's present laboratory was opened in 1943, for research and washability determinations. Expansion of the latter activity to fulfill an increasing number of requests from the coal industry has largely occupied present facilities.

The new building permits extension of the research phase; and will enable long range studies to be maintained on a continuous basis, using commercial size equipment. Included in the program are expanded projects on hydraulic jig, pneumatic jig, trough and dense media cleaning. The new facilities also allow additional studies on crushing, screening, thermal and centrifugal drying, pumps, sludge recovery, and water conditioning.

Another activity will be a continuing series of tests on equipment operation. They will be for the purpose of establishing operating characteristics and mechanical efficiencies of both new equipment, and new models of existing machines.

WEIRTON OPEN HEARTH HAS 550 TONS CAPACITY

▲ The world's largest open hearth furnace, a giant of 550-ton capacity, went into operation here recently at the Weirton Steel Corp.'s plant after Basic Refractories, Inc. completed installation of the bottom in a record time of 57 hours.

When this furnace goes into peak operation in October it will more than triple the output of the average 160-ton open hearth. It will produce about 100 tons more steel each tapping than its nearest rival, Great Lakes Steel Corp.'s No. 17 furnace, which leads the industry with 500-ton heats.

Weirton's No. 1, as this 550-ton "baby" is called, stands as an example of the latest in planning and construction techniques in the steel industry. Nothing was spared in making it not only the largest, but also the finest open hearth operating.

This furnace is a composite of the best features of open hearth furnaces across the country. About the only major part that didn't undergo design changes was the bottom. Open hearth refractories are not merely an accessory to the furnace. They themselves are the furnace, to all intents and

YOU CAN BE **SURE**.. IF IT'S

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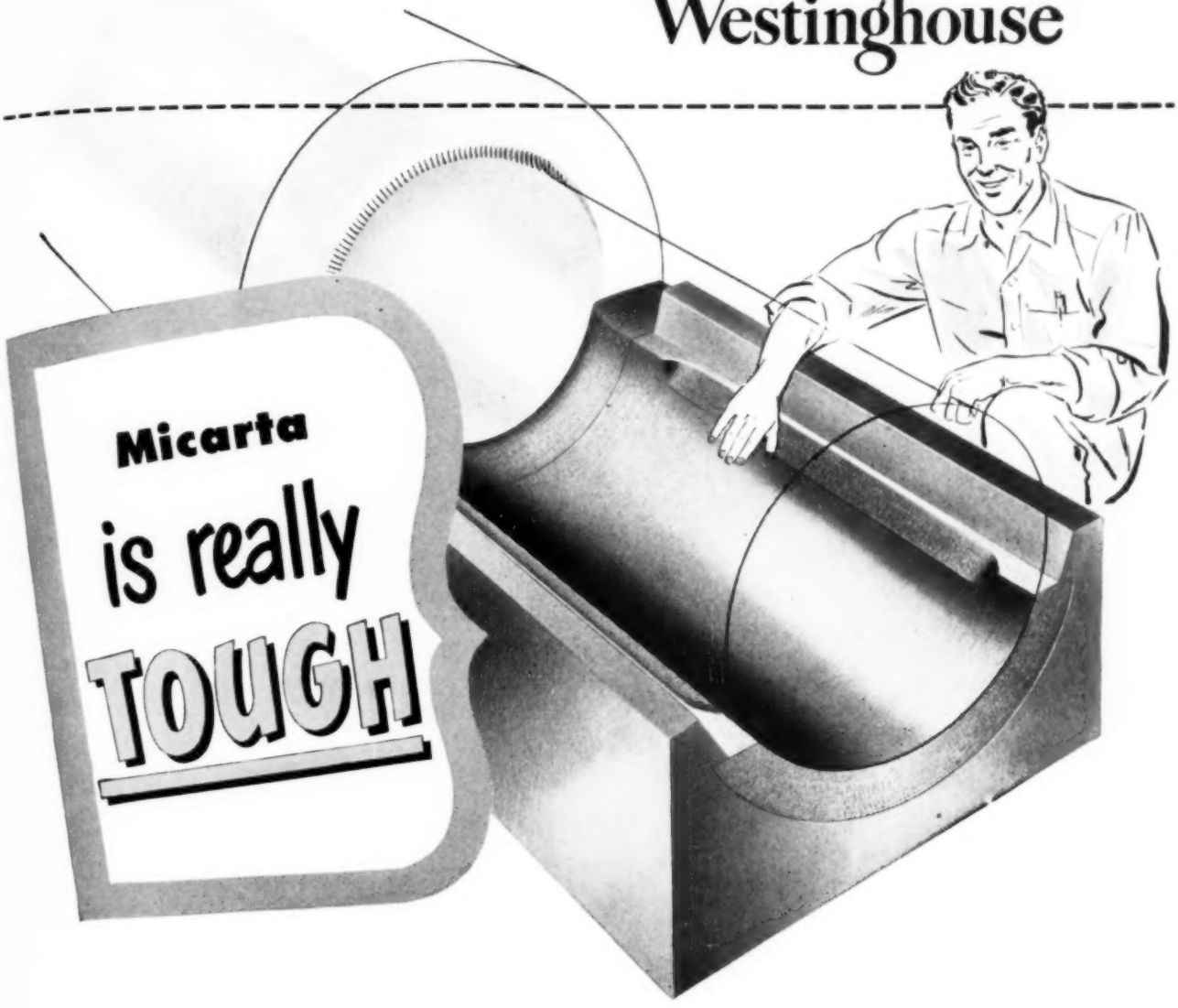

. . . wears 10 to 15 times longer—
Micarta bearings last longer—10 to 15 times longer than lignum vitae—up to 80 times longer than metals.

That's because Micarta is really tough . . . because it's resilient, smooth and self-polishing—because it exceeds the compressive strength of steel, pound for pound.

This slow rate of wear means increased tonnage through fewer shutdowns for replacement . . . fewer screwdown adjustments and test bars. Costs are cut through savings in replacement expense, and prevention of damage to rolls and roll necks.

Micarta also improves steel-plate quality. Better holding of gauge results from its dense, hard, wear-resisting qualities. Closer tolerances on rolling fine-gauge materials are obtained.

Micarta can improve operation, cut costs in other ways, too. For data and application help, call your nearby Westinghouse office. Ask for Book B-3776, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-06423

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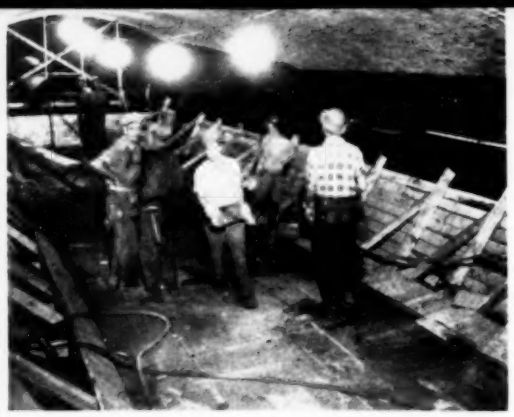
Micarta



Peak operation of this new furnace is to begin this month.

purposes. The steel work of the main structure is merely a frame which helps support the refractories.

The refractories used in the bottom and banks must be capable of holding molten steel at temperatures in the neighborhood of 3000 F, and withstanding the chemical and physical action of the slags normally encountered in making steel by the basic process.

In 1947, when a new bottom was needed for Weirton's No. 12 furnace, Basic Refractories installed one of magnesia ramming mix, magnesia being the refractory oxide of magnesium. Liquid iron oxide comes very close to being the "universal solvent" sought by the alchemist. Among the materials commonly used in the open hearth furnace, magnesia has the greatest resistance to this liquid. The bottom was installed by ramming the chemically bonded mixture with pneumatic rammers. The idea of ramming a bottom is almost as old as the basic open hearth furnace itself. But there were formidable obstacles which discouraged the use of rammed bottoms until Ramix, the original commercial magnesia ramming refractory, was introduced by Basic Refractories in 1939.

In 1947, after eight years of research, Ramset, an improved version of Ramix was introduced by the same company. After being proved highly successful on 11 of the 12 furnaces at Weirton, this type bottom was also installed in the new Number One.

The old method of burning in successive layers of bottom refractory often took up to three weeks. The bottom of this new furnace was installed in the record breaking time of 57 hours. Open hearth specialists from Basic Refractories supervised the job. The Ramset was mixed with water in an ordinary concrete mixer and carried into the furnace on a bulk conveyor. Crews started on the bottom September 3rd at 1:40 p.m. and completed the job September 5th at 10:50 p.m. One hundred and seventy-eight tons of this chemically bonded refractory was used to form a layer nearly 13 inches thick on the bottom at the taphole and 15 inches thick on the ends.

On Tuesday, September 6th, 12 cars of railroad ties were fired to dry out the furnace. On September 8th the oil burners were lighted and the furnace heated to approximately 2950 degrees Fahrenheit, so as to "burn in" the bottom.

The first heat was tapped out Monday morning and the furnace bottom installation was proved successful. These heats were smaller than the capacity 550-tons of molten steel this furnace is capable of because of the lack of auxiliary equipment large enough to handle a load that size. The largest ladles and ladle crane in the world have been ordered and will be ready for maximum production in October.

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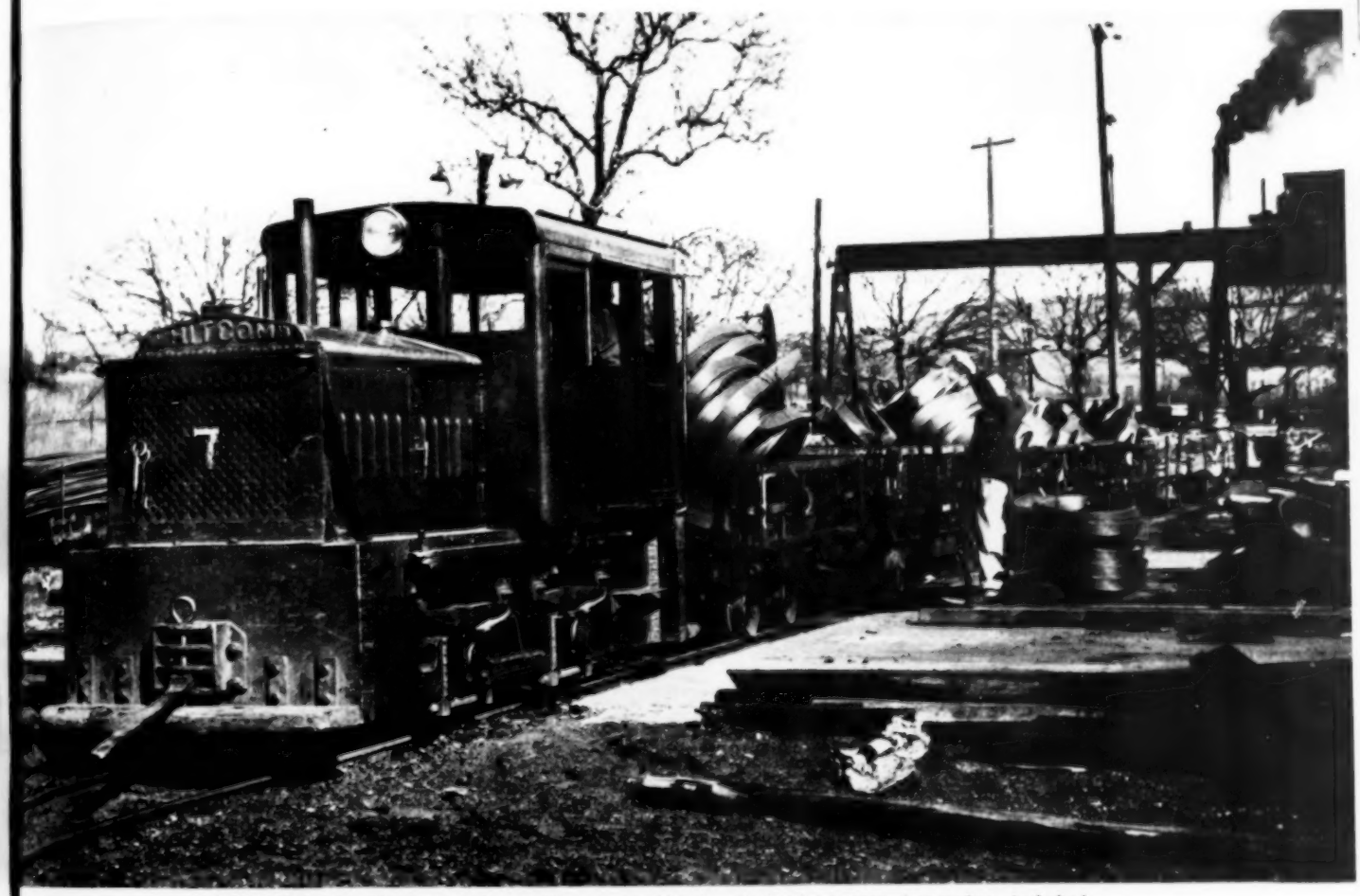
32 Years and 11 Locomotives Later They're Still Choosing WHITCOMB Locomotives



WHITCOMB 10-ton Diesel Locomotive spotting cars of strip alloy steel under a crane at an eastern steel plant. This is one of the first of eleven Whitcomb Industrial Diesels put into operation by this steel plant since 1917.

The highest testimonial you can give a product is to reorder. And eleven times since 1917 an important eastern steel plant has paid this compliment to Whitcomb locomotives. The first order, 32 years ago, was for a 4½-ton gasoline locomotive; the latest order, in 1948, called for two custom-built 10-ton Whitcomb Diesels.

The design, the engineering, the equipment of Whitcomb Industrial Locomotives has changed a great deal since 1917. But one thing has remained constant — QUALITY. For it has always been the Whitcomb policy to build the *finest* locomotive of its kind, the *best* locomotive of the times. That's why throughout the steel industry today you'll find modern Whitcomb Diesels working beside Whitcomb models built a generation ago. A Whitcomb is hard to wear out.

Write us today for full information on Whitcomb Locomotives — Diesel mechanicals from 3 to 30 tons; Diesel electrics from 25 to 95 tons.

There is no power more economical than Diesel; no Diesel locomotive finer than a Whitcomb.

Whitcomb 10-ton Diesel, in switching operation, hauls bars and rods to storage.

Whitcomb 10-ton locomotive switching hoppers of ferro-chrome to the electric furnaces.

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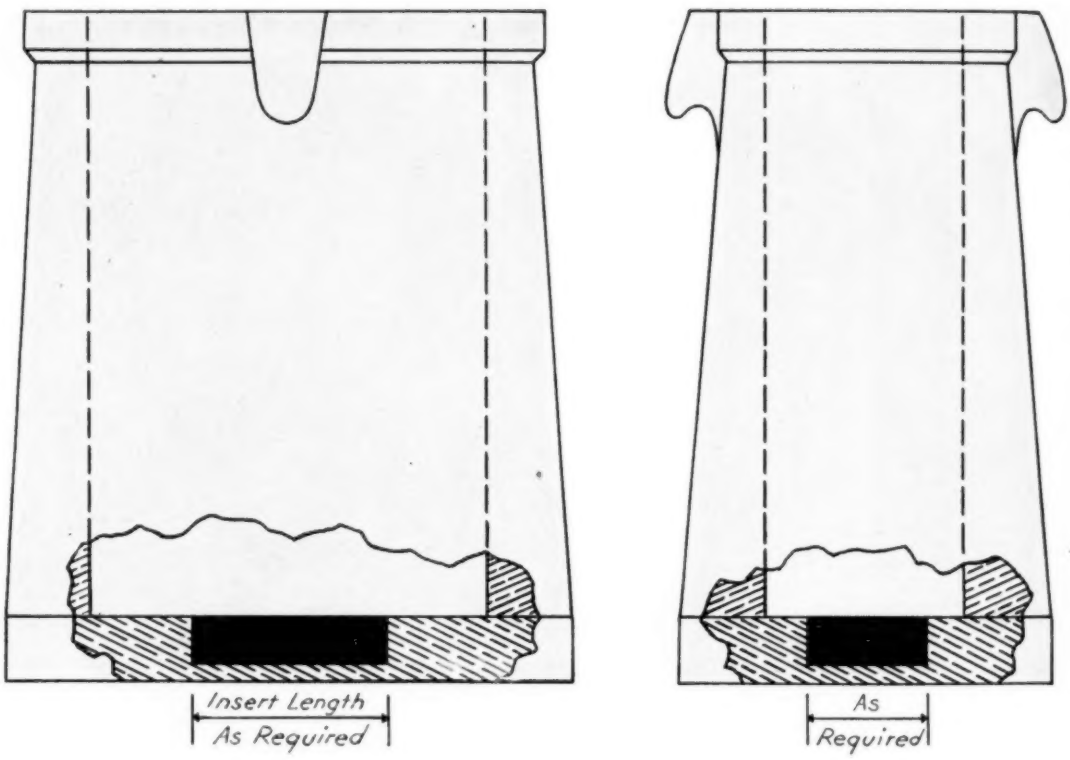

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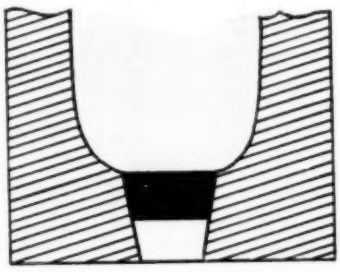

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Personnel News...

Walter F. Nicoden has been appointed assistant general superintendent of Youngstown, Ohio, district works of Carnegie-Illinois Steel Corp. He goes to Youngstown district works from Edgar Thomson works of Carnegie-Illinois, Braddock, Pa., where he has been assistant general superintendent. He will be succeeded there by **Edward J. Parsons,** who has been superintendent of steel production at Youngstown. A native of Monessen, Pa., Mr. Nicoden was graduated from Pennsylvania State College in 1931 and joined Homestead district works of Carnegie-Illinois in 1933. After three years in Homestead's metallurgical department, he became chief clerk in the open hearth division, later serving successively as assistant superintendent of the No. 3 and No. 4 open hearth shops. In 1940, he became division open hearth superintendent at Homestead and was appointed assistant general superintendent at Edgar Thomson in 1945. Mr. Parsons started with Carnegie-Illinois at Vandergrift, Pa., in 1922. After several promotions, he was named assistant division superintendent there and in 1941 came to Youngstown as assistant to the open hearth superintendent. Later, he was promoted to Ohio works open hearth superintendent, and in 1946, he became superintendent of steel production at Youngstown.

John L. Warner, assistant superintendent at the South Chicago coke plant of Youngstown Sheet and Tube Co., has been elected secretary of the Blast Furnace and Coke Association of the Chicago district. Mr. Warner, a native of Lancaster, Ohio, began his coke career with the Toledo Furnace Co. at Toledo, Ohio. From there he went to the Brier Hill Steel Co. at Youngstown, Ohio, then to Wisconsin Steel Co. in Chicago. In 1924 he joined American Smelting and Refining Co. to help operate the first by-product coke plant built in Mexico. When Mr. Warner returned to the United States, he joined Hudson Valley Coke Corp. at Troy, N. Y. In 1928 he went to Youngstown's South Chicago plant.

Gerald F. Twist was named manager of the Peerless Pump division of Food Machinery and Chemical Corp. with headquarters at Los Angeles. Mr. Twist has an extensive background in engineering. Following his graduation from the Stanford University's school of mechanical engineering, he became associated with the Anderson-Barngrover division, producer of canning equipment. Shortly thereafter, he accepted a position in the experimental department of the Atlas Imperial Diesel Engine Co. at Oakland, Calif. Mr. Twist eventually became a director and executive vice president of Atlas, resigning in 1947 to take charge of FMC's new corn harvester manufacturing operation in Indiana. In January of this year, he was made a vice president and manager of FMC's newly acquired subsidiary, the Stokes and Smith Co. of Philadelphia.

James E. Brown was appointed to a newly-created position of assistant general superintendent of American Steel & Wire Co.'s Cuyahoga works, Cleveland, Ohio. Mr. Brown, a veteran of 20 years' service with American Steel & Wire, moves to his new assignment from the staff of **H. B. Jordan,** vice president-operations of the company. He will serve as assistant to **H. J. Jenter,** general superintendent of Cuyahoga works, largest of the five wire company plants in the Cleveland area. Starting as a weigher in the company's Newburgh wire works in 1930, Mr. Brown later became a tester and wire drawer, advancing to the position of general foreman at the same plant. He spent two years at Cuyahoga works, returning to Newburgh in 1945 as works superintendent. In 1947 he was transferred to Mr. Jordan's staff.

Charles A. Butcher has been elected a vice president of Elliott Co. Mr. Butcher will continue to function as general manager of the Crocker-Wheeler Electric Manufacturing Co., Ampere, N. J., a recently acquired division of Elliott Co.

Milton T. Carleton has been appointed works manager of Cleveland Crane & Engineering Co., Wickliffe, Ohio. Mr. Carleton formerly was works manager of the Cleveland division of E. W. Bliss Co. for 14 years and has a background of over 35 years in all phases of heavy machinery manufacturing.

Edward S. Steigner, a member of Youngstown Sheet and Tube Co.'s metallurgical department for 15 years,

GERALD F. TWIST

JAMES E. BROWN

CHARLES A. BUTCHER

MILTON T. CARLETON

FOR HARD FACING AND REPAIR

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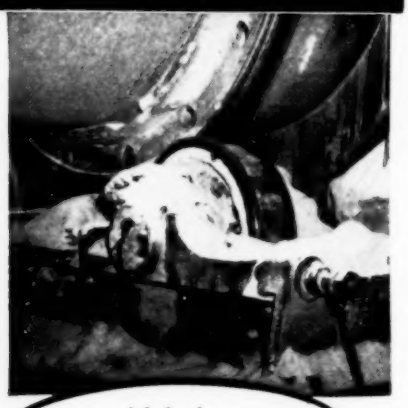

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Hardfacing with Amsco TOOLFACE provides the necessary toughness and wear resistance for parts like the trunnion wheels of this lime kiln. The wheels operate in an abrasive limestone dust under 40 tons pressure. TOOLFACE is recommended for abrasion resistance at high temperatures (up to 1100°F) where toughness is required... in this range TOOLFACE is both harder and tougher than the popular cobalt base alloys (No. 1 and 6). Typical uses for TOOLFACE are in steel mill tong bits... open hearth charging ram peels... chipper knives and tube cleaners in lumbering... and in metalworking cutting tools for lathes, shapers, and similar machines. TOOLFACE rods and electrodes are of a high speed tool steel composition... are readily welded to mild steel bases... have a deposit hardness of 575-675 BHN. Parts after welding may be forged, softened for machining and re-heat treated to original hardness. Write for Bulletin 1047-W.

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Foundries at Chicago Heights, Ill., New Castle, Del., Denver, Colo., Oakland, Calif., Los Angeles, Calif., St. Louis, Mo.
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has been appointed tubular products development engineer with headquarters in the Campbell works office building, Youngstown, Ohio.

John B. Hayes has been appointed sales representative for the electrode division of Great Lakes Carbon Corp. Mr. Hayes will handle sales of carbon and graphite electrodes and other carbon products in nine southern states. Mr. Hayes is head of the J. B. Hayes Co., Birmingham, Ala. He was connected with Union Carbide and Carbon Corp. for 16 years before founding his company in 1943.

F. Penn Holter has been appointed manager of manufacturing, General Electric Co.'s construction materials department at Bridgeport, Conn., succeeding **E. J. Harrington** who has been assigned to the staff of the vice president in charge of manufacturing policy.

C. J. Moore, manager, Pittsburgh branch, has been appointed manager of the railway and motive power sales division, it is announced by Electric Storage Battery Co., Philadelphia, Pa. Mr. Moore brings to his new position previous experience, having been supervisor of motive power sales from 1942 to 1946 when he was

C. J. MOORE

transferred back to the Pittsburgh branch as assistant manager and shortly after appointed manager.

C. H. Leet was named manager of the Pittsburgh branch of Electric Storage Battery Co., Philadelphia, Pa. Mr. Leet entered the employ of the company in 1938 as a salesman in the industrial battery department of the Pittsburgh branch. He was graduated from Cornell University in electrical engineering. Prior to entering the service of Exide, Mr. Leet was employed by the General Electric Co.

E. G. Schroeder was appointed to the position of field sales manager of Electric Products Co. In his new position Mr. Schroeder will supervise all district sales activities. Mr. Schroeder brings to his new position a broad experience in electrical sales and engineering gained by a year with the New York State Electric and Gas Corp., and over seven years with the General Electric Co. He joined Electric Products Co. in October, 1945, to head-up their Detroit district office.

Henry S. Hall has been appointed assistant manager of the combustion control department of Morgan Construction Co., Worcester, Mass. Mr. Hall was previously the fuel engineer of the Lukens Steel Co., Coatesville, Pa. Mr. Hall holds a Bachelor of Science

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The Keystone Porcelain-Covered Giant Strain Insulator contains a standard, mica-insulating, strain unit especially designed for circuits up to 750 volts. All metal parts are hot galvanized and can be furnished with two threaded studs, ⅝-inch diameter for attachment of eyes and clevises. For other applications, such as the insulator member of a third rail supporting insulator, they are supplied with two ⅝-inch tapped holes. Add to this an average tensile strength of 10,000 pounds and it can be seen why Keystone's Giant Strain Insulator is the answer when dependable insulation is required in the nation's steel mills.

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This double reduction De Laval Worm Gear Speed Reducer is available in many standard ratio combinations, with horizontal or vertical output shafts and is but one of 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

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degree in mechanical engineering from the University of Pittsburgh. He has been employed in the steel industry since 1925. He was test engineer for Youngstown Sheet and Tube Co. from 1925 to 1928. From 1928 to 1940, he was with Armco Steel Corp. in various capacities as follows: open hearth fuel engineer, open hearth metallurgist, assistant superintendent, open hearth. In 1940, he went with Lukens Steel Co. as fuel engineer, holding that position until his present appointment.

William F. Chase was recently elected president of the Smaller Manufacturers' Council of Pittsburgh. Mr. Chase, president of Bearing Service Co., will head the council which is affiliated with the Pittsburgh Chamber of Commerce and has a membership of more than 250 industrial firms in the Pittsburgh area. Other officers elected were: **E. M. Rodenbaugh,** first vice president; **D. D. Munroe,** second vice president; **L. L. Vayda,** secretary, and **H. A. Calderwood,** treasurer.

D. B. Hendryx, who has been chief engineer for Harbison-Walker Refractories Co. for the past 21 years, has tendered his resignation in order to establish his own office for engineering and consultant work. Mr. Hendryx will also do some consultant work for Harbison-Walker. **R. P. Snyder,** who has been associated

R. P. SNYDER

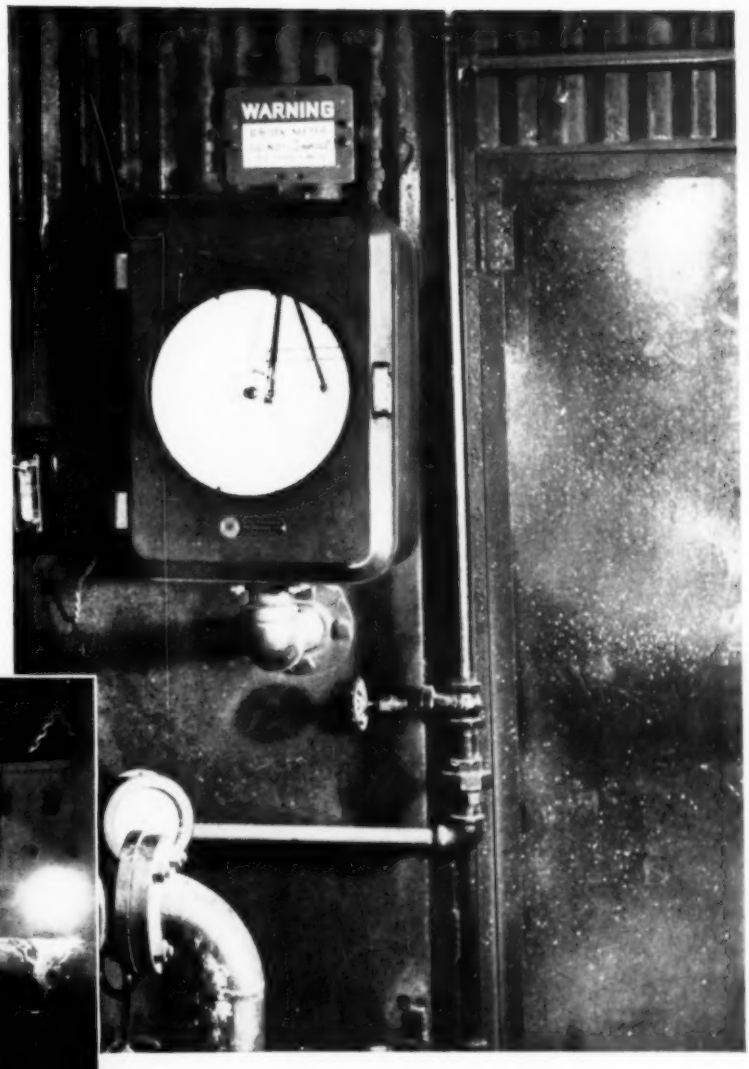
with Harbison-Walker Refractories Co. and the Northwest Magnesite Co. for the past 16 years, will succeed Mr. Hendryx as chief engineer.

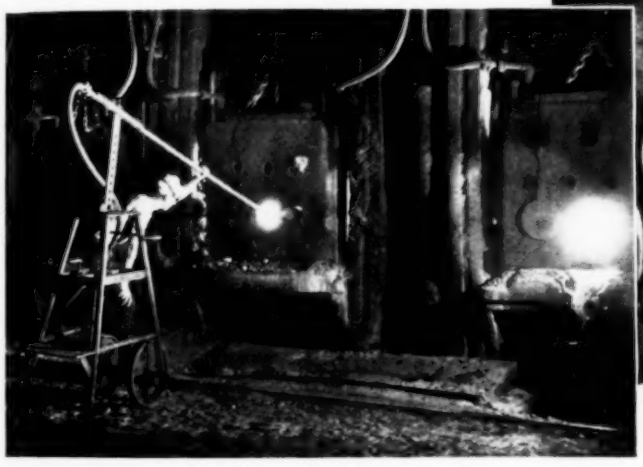
Darry G. Holt, formerly assistant manager of E. W. Bliss Co., Salem, Ohio, is now general maintenance superintendent, Compania de Acero del Pacifico, Talcahuano, Chile, South America.

Darwin E. Hachat, former general foreman of the power division, has been promoted to superintendent of power at the Indiana Harbor, Ind., plant of Youngstown Sheet and Tube Co. He has been with the company 20 years.

F. E. Fairman, Jr., has been appointed manager of sales, transformer and allied products division, General Electric Co., Pittsfield, Mass. Mr. Fairman was formerly vice president and general manager of the Peerless Pump division, Food Machinery and Chemical Corp. For a period of some twenty-three years, Mr. Fairman was associated with the switch gear division of the General Electric Co., except for the interval

Oxygen measurement is a routine job for HAGAN RING BALANCE FLOW METERS





Most problems of oxygen measurement in steel mills are due to the sudden and wide fluctuations in oxygen use. In open hearth applications, for example, there may be a comparatively low and steady flow of oxygen for relatively long periods of time together with tremendous surges of comparatively brief duration.

In applications of this kind, the meter must measure accurately at low flows, must respond quickly to all fluctuations, and must have sufficient range to measure peak flows.

The Hagan Ring Balance Meter meets these requirements without difficulty, giving an accurate and easily-read record on a standard 24-hour chart, and also, if desired, continuously totalizing the flow. All of this is accomplished with a standard model, single-ring meter, equipped with a simple mechanical integrator.

If you want a temperature or pressure record, or temperature or pressure compensation, there is a **standard** Hagan Ring Balance Meter which will give you either or both. Temperature, pressure, compensated flow and uncompensated flow can all be recorded on a single chart. The integrator automatically totalizes compensated flow.

Measurement of oxygen flow is only one application of these extremely versatile meters. For full information, mail the coupon below, or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

METALLURGICAL FURNACE CONTROL SYSTEMS

RING BALANCE FLOW AND PRESSURE INSTRUMENTS

BOILER COMBUSTION CONTROL SYSTEMS

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Pittsburgh 30, Pa.

Please send me your Ring Balance Meter Bulletin 2M48.

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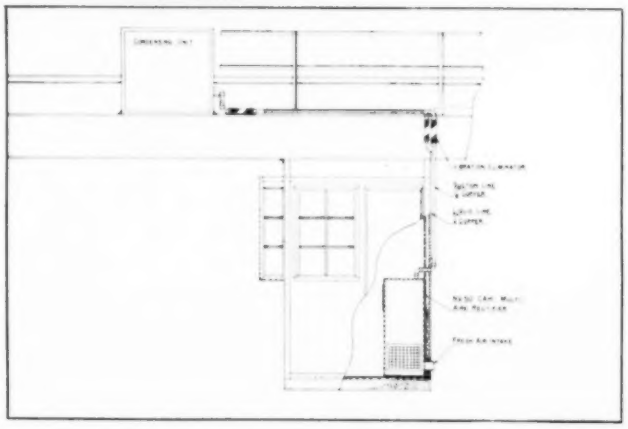
Sizes, Weights, Costs REDUCED in...



1950 MODELS

LINTERN

Aire-Rectifier

The 1950 models of the "Little Giant" split system Aire-Rectifier now in production involve significant reductions in size and weight, yet with no sacrifice in capacity. Consequent savings in production are passed along to the buyers.

There are three new models in this series: AC 50-13 of 13,000 BTU capacity; AC 50-18 of 18,000 BTU capacity; and AC 50-27 of 27,000 BTU capacity. Typical of the saving in size and weight is AC 50-13. Its condenser unit measures only 38" long, 17" deep, and 35" high — weight, 700 lbs., as compared with the previous model, which measured 57" long, 23" deep, and 49" high — weight, 1,420 lbs.

The control panel is now located in the cab and easily accessible along with thermostats and control switch. Thus all electrical equipment is protected and gives longer operating life.

The split system offers several definite advantages. (1) Reduced engineering costs. (2) Big savings by elimination of expensive, efficiency-reducing air ducts. (3) Higher cooling efficiency in the cab. (4) Greater flexibility in location of all equipment. (5) Lengthened life of operating equipment because of protection from excessive radiant heat and greater accessibility for service. (6) Location of Aire-Rectifier on existing cranes without moving any equipment. Savings run from $1,000 to $2,500 per installation.

Let us send you complete information.

THE LINTERN CORPORATION

54 LINCOLN AVENUE • BEREA, OHIO

when he was steel mill specialist for the Pittsburgh district from 1927 until 1933.

E. R. Schneider has been named director of purchases for Great Lakes Steel Corp., Ecorse, Mich. **R. J. Webber** has been promoted to assistant director of purchases of the corporation. **F. E. Caskey** has been made purchasing agent.

J. L. Neudoerfer has been elected executive vice president of Wheeling Steel Corp., Wheeling, W. Va. **N. C. Reed** succeeds him as vice president in charge of sales, having previously served as general manager of sales. **W. M. Hall**, formerly assistant general manager of sales, succeeds Mr. Reed as general manager of sales.

John C. Murray was named general sales manager of Edgar E. Brosius Co., Inc. He will make his headquarters at the company's plant in Sharpsburg, Pa. Mr.

JOHN C. MURRAY

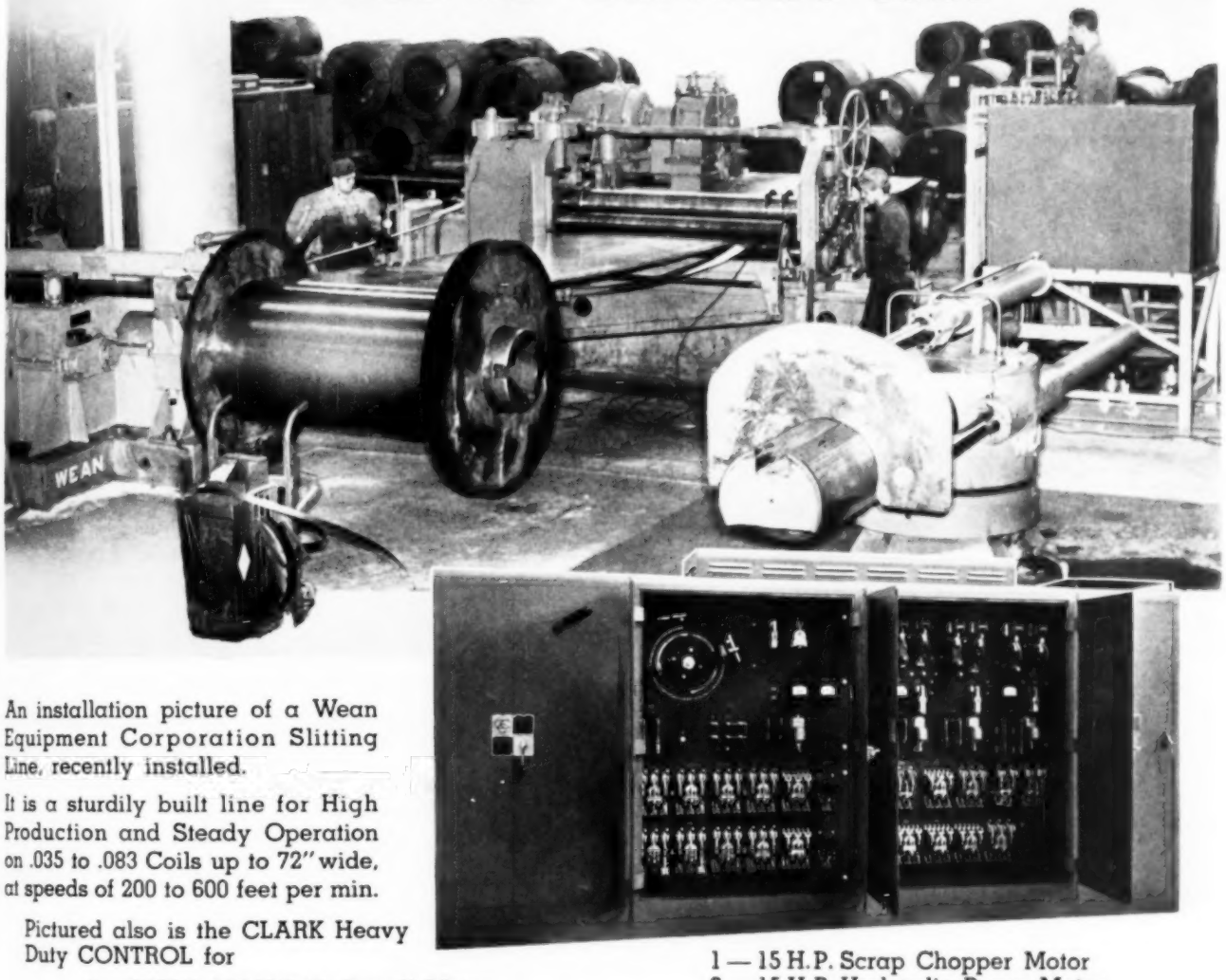
Murray has most recently been affiliated with Republic Steel Corp., Youngstown, Ohio. He previously spent 33 years with Jones & Laughlin Steel Corp., Pittsburgh, Pa., as assistant general superintendent of the Pittsburgh works.

Dr. Anson Hayes has asked to be released as director emeritus of the research laboratories and special consultant to the general management of Armco Steel Corp. to enter private business. Dr. Hayes has been director emeritus of the Armco research laboratories since April, 1947. He first came to the Armco organization as chief chemist in 1928 from Iowa State College of Agriculture and Mechanic Arts where he was professor of chemistry. He was appointed director of Armco research in August, 1929. During the years he served in this capacity, Armco research laboratories have made great progress and a number of new types of special purpose steels were developed as well as new methods for manufacturing new products. Dr. Hayes was elected vice president of Armco in November, 1946.

E. A. Matteson, formerly sales engineer in the sheet and strip equipment division of Aetna-Standard Engineering Co., Youngstown, Ohio, has been made manager export sales and manager patent division. **R. L. Allshouse**, formerly sales engineer in the sheet and strip equipment division, has become sales manager of sheet and strip equipment division. **D. C. Mills** of the proposal engineering department has become a sales engineer.

Another CLARK Engineered CONTROL

FOR 72" SLITTING LINE



An installation picture of a Wean Equipment Corporation Slitting Line, recently installed.

It is a sturdily built line for High Production and Steady Operation on .035 to .083 Coils up to 72" wide, at speeds of 200 to 600 feet per min.

Pictured also is the CLARK Heavy Duty CONTROL for

1 — 20 H.P. 230 V D.C. Payoff Motor
1 — 40 H.P. 230 V D.C. Slitter Motor
1 — 60 H.P. 230 V D.C. Reel Motor
1 — 75 KW 250 V D.C. Main Generator
1 — 7½ KW 250 V D.C. Exciter
1 — 4 KW 50 V D.C. Payoff Booster
1 — 12 KW 50 V D.C. Reel Booster

In the left hand closed section of the cabinet is the 440 V 3 ph. 60 cycle A.C. Control for

1 — 25 H.P. Main M. G. Set
1 — 25 H.P. Main M. G. Set Booster
1 — 15 H.P. Scrap Chopper Motor
2 — 15 H.P. Hydraulic Pump Motor

The closed cabinet on the right houses control for 2—3 H.P. VSA set motors and 1 H.P. Payoff lubricating pump motor.

A special CLARK Bench Board is mounted so the operator has full view of the line. 2 CLARK Bulletin 106 Shoe Brakes are also part of the equipment and are mounted on the uncoiler and wind up reels.

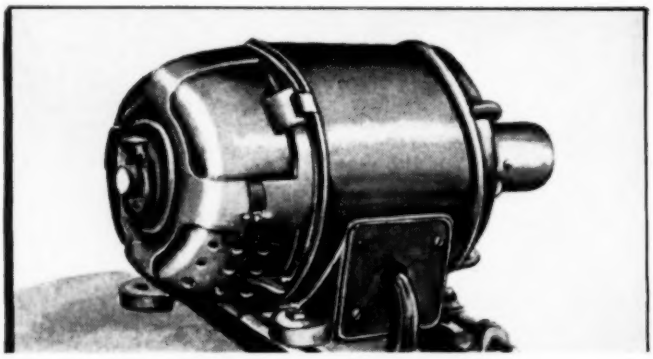
Due to CLARK's broad experience on Processing Line Controls, the entire line was put into successful production with very minor adjustments.

CLARK Engineers are at your service on all steel mill processing Line Control problems.

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

Short Circuits got you down?



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With its exclusive adhesive properties, NON-FLUID OIL does not creep or throw onto armatures to cause burnt-out windings from oil-soaked insulation. Motors run cooler and stoppages are reduced to an absolute minimum. You save on oil bills too because NON-FLUID OIL lubricates until entirely used up outlasting ordinary lubricants 3 to 5 times.

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WAREHOUSES: Atlanta, Ga. • Greenville, S. C. Charlotte, N. C. • Providence, R. I. • Chicago, Ill. St. Louis, Mo. • Detroit, Mich.

NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.

Floyd Hoskinson has joined Youngstown Sheet and Tube Co. as superintendent of the cold drawn bar department at the Brier Hill plant in Youngstown, Ohio. He succeeds **J. G. O'Malley** who left the company recently. At the age of 14, Mr. Hoskinson joined Union Drawn Steel Co. at Beaver Falls, Pa., as a draw bench helper, working there from 1907 to 1914. In 1915 he went with United Steel Co. at Canton, Ohio, as a bench operator, became general foreman there three years later and held that post until 1928.

From 1928 until 1940 Mr. Hoskinson was general foreman and superintendent for Donner Steel Co. of Buffalo, N. Y., which became a part of Republic Steel in 1930. From 1940 until recently Mr. Hoskinson was superintendent for Copperweld Steel Co. in Warren, Ohio.

J. D. Streett was named vice president in charge of development for Granite City Steel Co., Granite City, Ill. Mr. Streett was assistant to the president and has been with Granite City Steel since 1938. **N. P. Veeder**, former works manager, was made vice president in charge of operations. He entered employ of the company in 1934. **Erwin Niedringhaus**, former assistant sales manager in charge of tin plate, was promoted to the position of assistant to the president.

Joseph H. Parsons and **Robert B. Pogue** have been appointed vice presidents and **Rosser L. Wilson** has been appointed chief engineer of the Brake Shoe and Castings division of American Brake Shoe Co. Mr. Parsons, formerly assistant vice president, will be in charge of miscellaneous castings sales. Mr. Pogue, formerly chief engineer, continues in charge of engineering. He has been with Brake Shoe since 1916 and chief engineer of the division since 1937. Mr. Wilson, formerly assistant chief engineer, joined the company as an engineer in 1935.

Obituaries

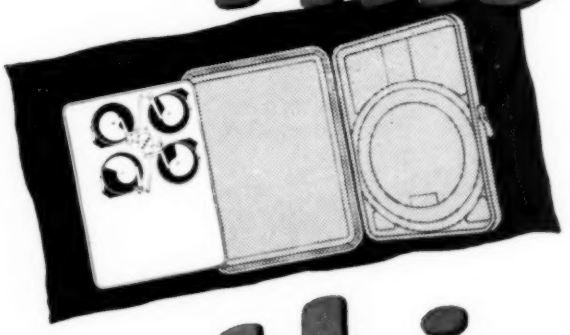
John Blair Sutton, 67, president of the Sutton Engineering Co., Bellefonte, Pa., died on September 25, 1949. He has been the company's president and chairman of the board since its formation in 1918. He had been associated with the Crucible Steel Co. of America for a number of years prior to forming the Sutton Engineering Co.

Bruce E. Tau, vice president of Freyn Engineering Co., passed away in Pittsburgh, September 24, while there on a business trip. He had been engaged in the construction field since 1916. He became identified with Freyn Engineering Co. in 1931.

Merton W. Morgan, chief engineer of Poole Foundry and Machine Co., Woodberry, Md., for the past 35 years, died recently. Previously he had been employed by Bethlehem Steel Co., Sparrows Point, Md., and by the Deane Pump division of Worthington Pump and Machinery Co. at Holyoke, Mass.

F. C. Watson, electrical superintendent, International Nickel Co., Inc., Huntington, W. Va., died recently.

you can have this



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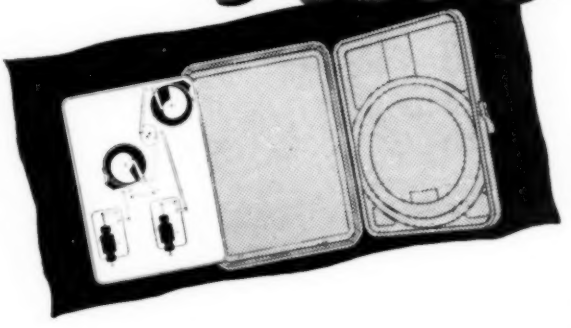

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P-18-S

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To learn how Bailey controls can save you money and speed up control installations, write for a copy of Bailey Bulletin No. 17.

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TEMPERATURE • FLOW • PRESSURE
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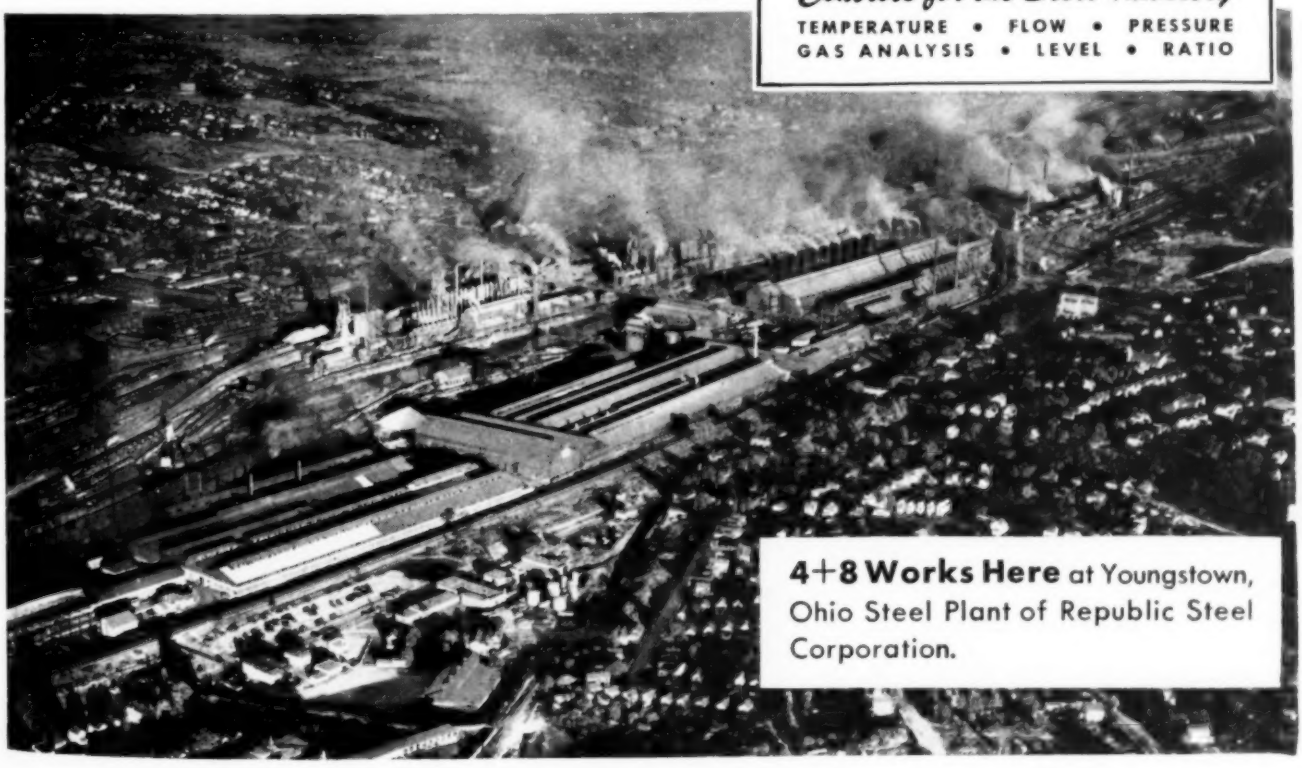
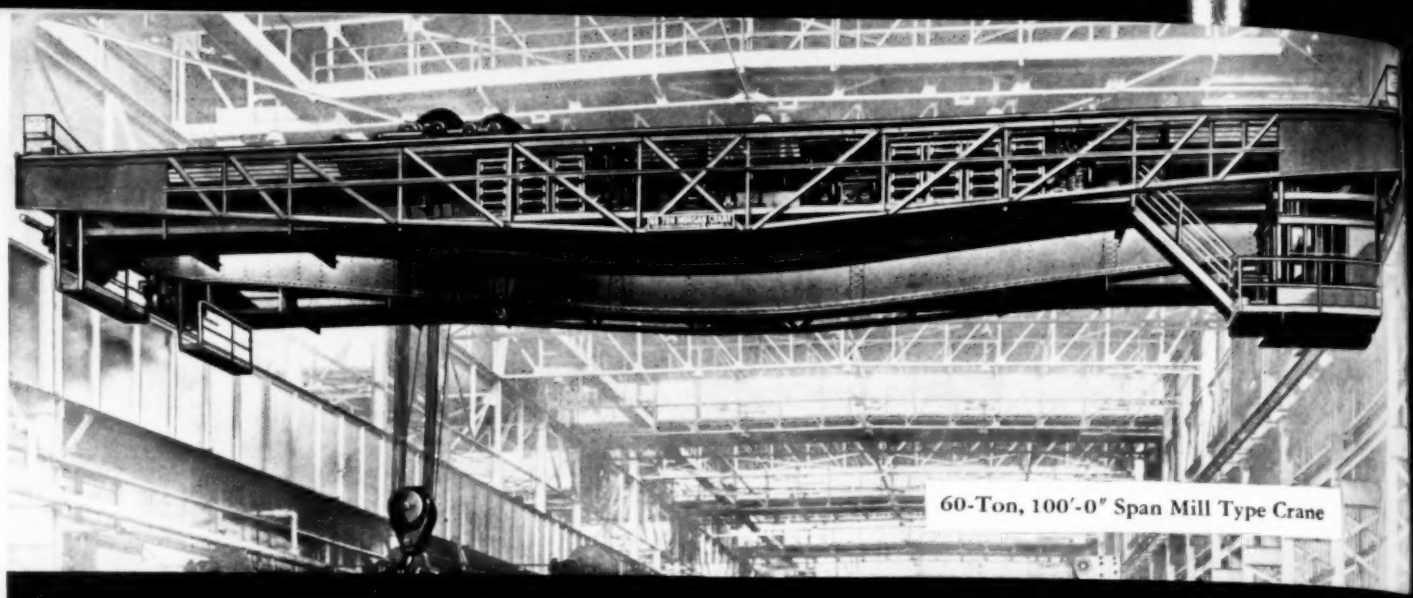


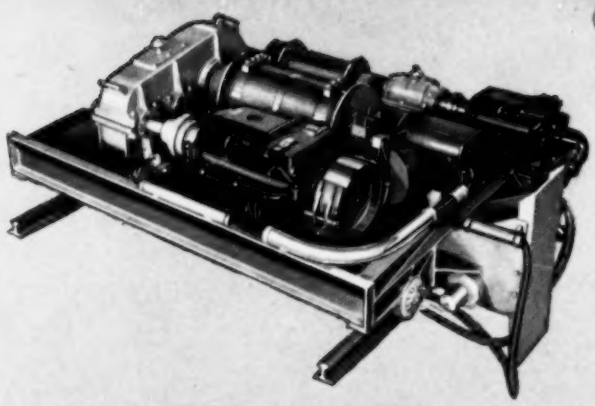
4+8 Works Here at Youngstown, Ohio Steel Plant of Republic Steel Corporation.



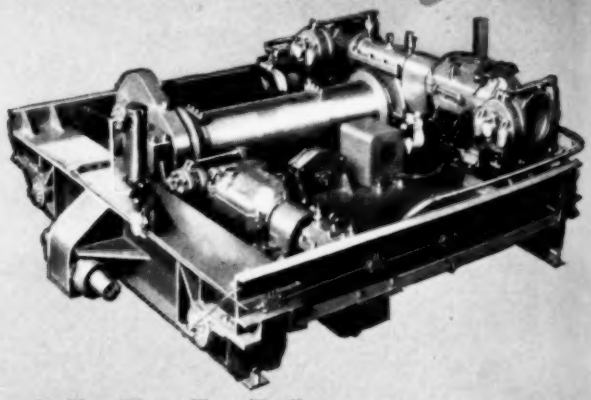
60-Ton, 100'-0" Span Mill Type Crane

TYPICAL MILL TYPE CRANES BUILT TO A. I. & S. E. SPECIFICATIONS

BUILT BY MORGAN *Engineering*

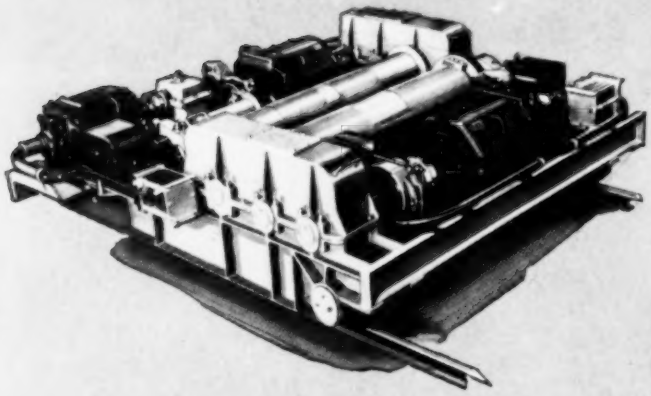


10-Ton Gear Box Type Trolley

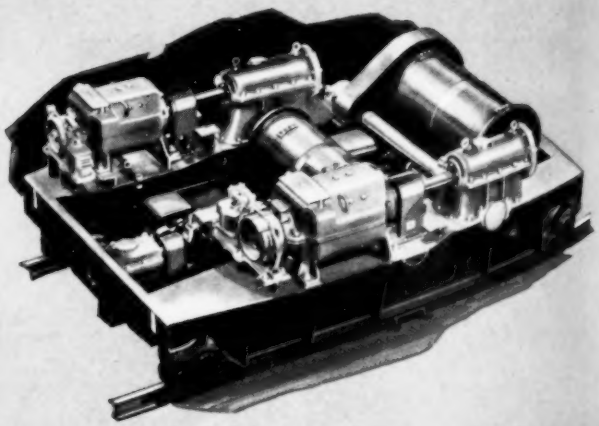


10-Ton Worm Type Trolley

30-Ton Gear Box Type Trolley



60-Ton Worm Type Trolley



THE MORGAN ENGINEERING CO., ALLIANCE, OHIO • PITTSBURGH—1420 OLIVER BUILDING

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Equipment News...

ECONOMICAL METHOD IS DEVELOPED FOR MAKING STEEL PLATE INTO PIPE

▲ Equipment has been developed for hydraulic press-forming and submerged arc-welding of steel plate into pipe, in thicknesses from ¼ in. to ½ in. or heavier, and sizes from 8⅝ in. up to 30 in., outside diameter, or larger. Heretofore, a mill for making these sizes by any conventional process has cost anywhere from four to seven million dollars. By the new process the initial investment in equipment, including tooling for a range of sizes such as indicated, has been brought down to anywhere from 1/3 to 1/6 of these amounts.

The complete mill is engineered and built by the Yoder Co. of Cleveland, Ohio, leading manufacturers of electric resistance weld pipe and tube mills. The latter type of mills are held to be most efficient in the range from ⅜ in. up to about 12 in. diam. In the range from 12 in. to 20 in., the advantage will in some cases lie with the latter, while in others it will lie with the new process, especially where lower production is aimed.

The low limit of size for economical operation of the new mills is estimated at about 8⅝ in. outside diameter, and the maximum at 30 in. or larger. The entire range between these sizes can be made in one mill, with one set of basic tooling, a big factor in reducing initial plant investment where a number of different sizes is to be made.

The equipment consists first of a plate flattener, edge trimmer, scrap chopper, edge scarfing and shot blast unit, such as ordinarily used in electric weld pipe mills in the preparation of skelp for forming and welding.

Equipment peculiar to the process are three specially designed hydraulic presses for step-by-step cold forming into round tubes prior to welding. Also one, two, or more welders, of the submerged arc type which, with wire feeds, flux hopper, flux reclaiming system and generators are supported on an overhead bridge. An entrance conveyor with chain type pusher propels the pipe through two pair of squeeze rolls. These, together with entrance and exit guide rolls, are mounted on a welded steel base under the bridge. A welding mandrel, with water cooled copper backup shoe, is supported on the overhead structure at the entrance end.

The tooling, too, is new and revolutionary. In general the hydraulic press dies are made for the largest size of pipe, and then built up by means of filler pieces for smaller sizes to be made. This system reduces tooling cost to a small fraction of what it is where each size requires a fairly complete change of rolls or dies.

By the combination of press-forming with arc-welding, each 40-ft length of pipe is perfectly formed and welded from end to end. No cropping is necessary and the only scrap loss consists of about ¼ in. of metal removed in an end-facing machine installed next to the hydrostatic testing unit at the end of the production line.

The mill is furnished complete with conveyors between the various operating and processing units, for a continuous production line, with added semi-automatic facilities for taking the cold-formed lengths into and out of temporary storage before proceeding to the welding and finishing operations, and to final storage before shipping.

Optional finishing equipment consists of units customarily employed for internal welding, flanging of ends, sand blasting, prime coating,

Estimated Production, Press-Forming, Arc-Weld Pipe Mill

Pipe size, in.	Footage	Weight, lb per ft	Tons per year
12¾ x .250	910,000	33.4	15,197
16 x .312	580,000	52.3	15,167
20 x .375	388,000	78.6	15,259
26 x .438	250,000	119.0	14,875
30 x .500	193,000	158.0	15,287
Annual production	2,321,000	Feet or	75,785 Tons

MINIATURE MODELS OF MATERIAL MOVERS

At the recent AISE Convention free drawings of scale model Hyster straddle trucks and "Karry Kraws" were held every 20 minutes during a reception immediately following the Materials Handling Session of the Convention. Shown are: Frank C. Wier, materials handling superintendent, steel and tube division, Timken Roller Bearing Co.; John Winer, electrical engineer, Armco Steel Corp.; a Pittsburgh model, and John Lind, assistant general traffic manager, National Supply Co. In the Materials Handling Session, Mr. Wier discussed the use and savings of straddle trucks in the steel industry. The reception was held by Equipco Sales Co., a distributor for Hyster Co.

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By leasing Air Products generators and making your own oxygen from air, you can assure yourself a continuous supply—with no investment for equipment. Air Products generators extract your oxygen from the air and feed it right to your pipe line without handling.

If you use over 200,000 cubic feet of oxygen per month, you can get these advantages by leasing Air Products oxygen generators:

- **No Risk of Delivery Failures!**
- **No Evaporation Loss!**
- **No Residual Loss!**
- **No Expensive Handling and Delivery Costs!**

For full information about this modern method of solving your oxygen problems, drop us a line—telling us your peak and minimum oxygen loads per month. No obligation to you, of course.

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Assure Your Supply at low cost with

Air Products
OXYGEN GENERATORS

oven drying, enameling, wrapping, white washing, etc.

Typical operation might be considered single shift of the skelp preparation and forming line, with two welders, each operated three shifts, to match the cold-formed output.

To illustrate production possibilities with such a mill, on five different pipe sizes and weights, the following table gives figures estimated from performance records in a plant which has been in operation for about a year and a half.

By double-shift operation of the forming line, and doubling the number of welders, the production may be stepped up proportionately.

The world situation in respect to the manufacture of large sizes of steel pipe is that very few countries, except the U. S. A., Great Britain, Germany, and possibly one or two others, produce such pipe in sizes above 8 in. or 10 in. In most of the other countries, this product has to be imported, for use in large gas, oil, water and steam lines.

Heretofore, the initial investment required for the building and equipping of a plant for manufacture of large pipe has been so great as to make operation unprofitable on any volume of business which might be expected in most countries.

With one of the new process mills, established under favorable conditions as to tariff protection and local competition, annual requirements as low as 10,000 to 15,000 tons will in many countries be sufficient for profitable operation.

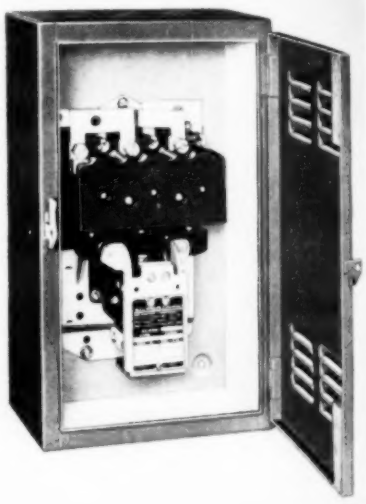
An additional factor favoring the establishment of the new type of plant in most countries, is that the freight on large pipe, by rail or water, is necessarily very high due to the very low weight in relation to bulk or cubic measurement. This characteristic greatly increases the cost of imports, as well as the freight between the place of importation and points of ultimate use within the importing country. The logical remedy is low-cost, low-production plants, located as close as possible to points of consumption.

Even within the boundaries of the U. S. A., the shipment of large pipe from plants located in the northeastern states to the southern, mountain and Pacific states, involves freight costs so high that the new process may be used to advantage in conversion plants located closer to these big markets.

NEW WELDER CONTACTOR NOW IN PRODUCTION

▲ The new Square D Size OW, 50 ampere welder contactor is now in production. It was designed to fill the need for a rugged contactor with long life and high speed operation for small spot welding machines up to 10 kva, 220 volts or 20 kva at 440 volts.

High rupturing capacity is assured by two double break contacts connected in series, giving a total of four breaks. Heavy copper bus straps allow large welder cables to be easily



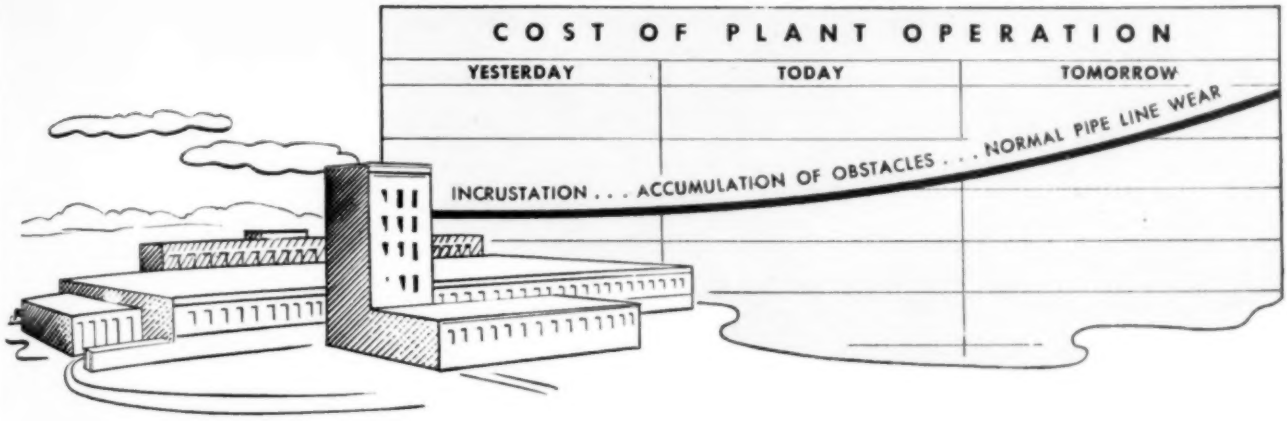
connected and are conveniently located for accessibility. Silver contacts provide exceptionally long life and never require cleaning or dressing.

A floating armature is pivoted on a hardened steel pin, and the pin bearing is hardened to insure long, trouble-free life. Magnet life has been increased by shortening armature travel and increasing air gap.

Accessibility for inspection and maintenance saves time and labor. Using only a screwdriver, an operator can remove for inspection or replace the movable contact assembly, terminals, contacts, and magnet coil.

WIDE STAINLESS STRIP STEEL IS ANNOUNCED

▲ A new 18-8 bright annealed stainless strip steel, claimed to be wider than anything heretofore produced by any manufacturer, has been announced by Wallingford Steel Co., Wallingford, Conn., a subsidiary of the Allegheny Ludlum Steel Corp.



A Simple Solution to Reduce Costs Resulting from "Unseen Pressure and Volume Losses"

FORMATION of incrustations and tubercles within the pipe cause unseen pressure and volume losses that complicate the work of the water works engineer. These UNSEEN losses cannot be overlooked.

NOW is the time to find out whether trouble is ahead in YOUR installation. An economical, general survey of existing conditions in your water supply and disposal systems, made by THE ENGINEERING DIVISION of the Pittsburgh Pipe Cleaner Company will save you many dollars in the future.

TAKE ADVANTAGE OF OUR COMPLETE SERVICE AND MAINTENANCE PROGRAM:

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- Hydraulic Analyses
- Pipe Cleaning
- Pipe Coating
- Industrial Waste Surveys
- Installation of new or replacement pipe for your present plant
- Design and installation of complete industrial waste disposal plants

▲

Contact Your Nearest Pittsburgh Pipe Cleaner Company ENGINEER TODAY!

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PITTSBURGH PIPE CLEANER COMPANY

133 Dahlem St., Pittsburgh 6, Pa.

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DETROIT • HOUSTON • NEW YORK • PHILADELPHIA • ST. LOUIS

Cold rolled up to 15 in. in width, the product will implement fabrication of many items previously unobtainable with bright annealed stainless, according to the manufacturer.

Wallingford Steel claims that the well-known advantages of this metal — its popularity, its brilliance in all tempers, its resistance to corrosion, and the fact that, due to elimination of rough and finish grinding, it is more economical to fabricate — have been retained intact in this wider bright annealed strip.

The battery cell filler has been thoroughly tested in field service.

BATTERY CELL FILLER AIDS MAINTENANCE

▲ A new and improved Exide battery cell-filler is announced by Electric Storage Battery Co. The new cell-filler will enable maintenance men to add water to storage batteries used in electric industrial trucks and tractors, quickly, accurately and easily. It has been field-tested thoroughly in this service.

The cell-filler consists of a tube with a nozzle at one end and at the other a handle which is equipped with a valve operated by finger control. At the valve or handle end is an electric signal lamp which flashes a warning when the water in the cell reaches the correct level.

The lamp is operated from five dry cells carried in a small steel case attached to a canvas belt, which goes around a maintenance man's waist; or from a 115/6 volt transformer.

The nozzle is molded of tough rubber to withstand severe operating conditions. The filler is so designed that if, through abnormal service conditions, certain parts are damaged, it may be dis-assembled and the damaged parts easily repaired or replaced.

SAFE SUSPENSION ASSURED WITH FIXTURE HANGER

▲ Permanently safe suspension of fluorescent lighting fixtures is doubly assured by the new and improved Appleton "SFH" fixture hanger. The "SFH" hanger is manufactured with a pair of snug fitting clips which hook firmly to the ears of the outlet box, supporting fixture in the event mounting screws work loose or rust through.

Equipped with pear-shaped screw holes, the hanger may be mounted in place without removing screws from outlet box. After screw heads clear holes, a ten-degree turn locks the hanger in place with safety clips behind ears in the outlet box.

Sliding clips are provided to take chains for suspending fixture. Held in desired position by corrugations in hanger plate, fixture may be swung in any direction by positioning clips. Knockout for Levolier switch is provided.

The fixture hanger is available with two-wire receptacle or with three-wire, twist-lock receptacle. May also be ordered complete with two five-foot chains, hooks, cord and clips.

CRANE BUILDERS Since 1903

BEDFORD CRANES

Capacities 5 to 150 Tons

Designed and Engineered to Meet Your Requirements

Any Span or Lift
Send For Your
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ELECTRIC OVERHEAD TRAVELING CRANES
GANTRY CRANES • STEEL DERRICKS
BUILT TO YOUR SPECIFICATIONS
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BEDFORD, INDIANA
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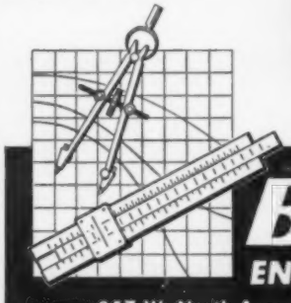
Gray
Iron
Castings

The average open hearth furnace can be *REVERSED in 9 to 10 SECONDS* with the

BLOOM TIME CYCLE REVERSAL SYSTEM

Inside this factory-wired, compact cabinet is all the equipment needed to control the fast, automatic reversal of an open hearth furnace. Easy to install, firing time cycles instantly adjustable, push-button reverses furnace before end of cycle if desired.



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BLOOM ENGINEERING CO., INC.

857 W. North Avenue — Pittsburgh 12, Pa.

There is a demand for copies of the following Yearly Proceedings:

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WARE
HI-LAG
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1. Square ends increase contact areas and maintain low resistance without overheating:
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3. Narrow cross members allow for expansion without bending:
4. Fusing points open with a minimum of arcing on short circuits.

For dependable time lag and 100% protection — specify WARE HI-LAG FUSES.

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Gear Type
Coupling
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For Dimensions, Ratings, Service Factors, Etc. On All Types — Write For Descriptive Catalog.

MANUFACTURED BY

JOHN WALDRON CORPORATION

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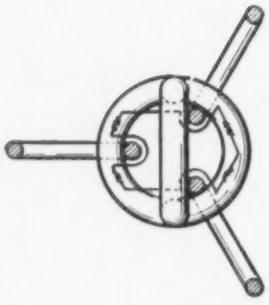
Sales Representatives in Principal Cities.

AJAX FLEXIBLE COUPLINGS

The fact that all the horsepower goes through the coupling emphasizes the importance of protecting direct-connected machines against misalignment.

AJAX FLEXIBLE COUPLING CO. INC., WESTFIELD, N. Y.

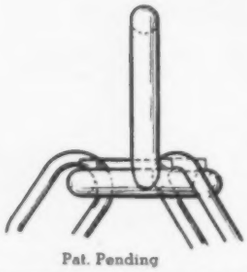
...LONG LASTING
MAGNET CHAINS



Heat-treated high alloy steel PLUS the patented ring to eliminate rubbing and twisting gives Downtown Frictionless Magnet Suspension Chains up to 3 times the life of old-style suspension chains.

Locating Plate keeps magnet face level.

No more periodic annealing.



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For these reasons Downtown Suspension Chains offer you best dollar value.

Each chain for 55 inch magnets is tested to 89,000 lbs. Each chain for 65 inch magnets is tested to 115,000 lbs. Don't delay! Write now for prices. Prompt shipment from stock.

DOWNTOWN *Company*

1836 EUCLID AVE. • CLEVELAND 15, OHIO

Introducing the New
"Luminum-Line" Plate and Pipe Marker

IT'S ALUMINUM
50% Lighter than Steel Holders

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This new "Safety" steel stamp holder of cast aluminum is "easy on the operator" . . . gives long-life, rugged and dependable service . . . for all heavy-duty plate and pipe marking.

Write today for data and proposal!

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SAFETY STEEL STAMPS

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MILL TYPE CRANES have *Plenty of Strength* WHERE STRENGTH IS NEEDED!

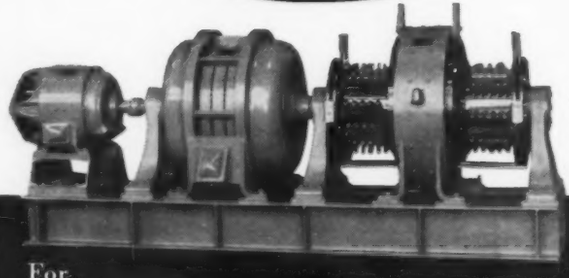
Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane *perfectly* to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.

"Built as you yourself would build them"

Write for our Bulletin "S".

VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

Motor Generators by COLUMBIA



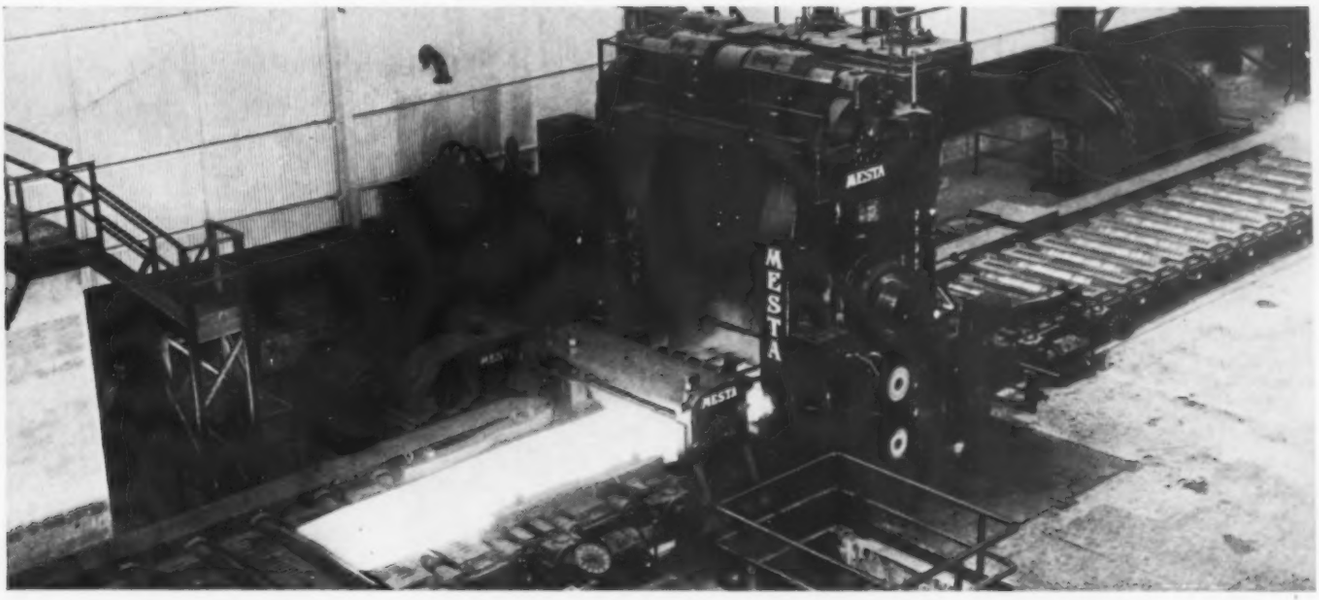
For
Electroplating — Anodizing
Electrocleaning — Electropolishing

There's a Columbia M-G Set available for your needs, whether you have a small plating bath or a large continuous strip plating line. Capacities up to 20,000 Amperes; 6 Volts and up. Dependable, performance proved, for many years. Your inquiries solicited.

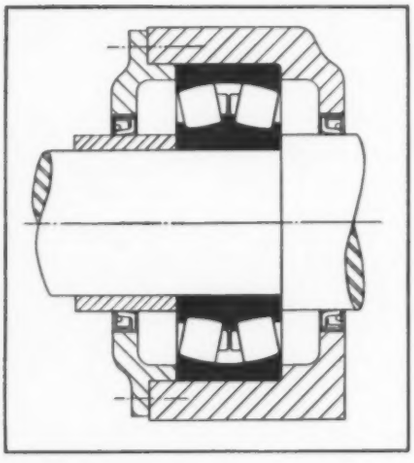
Write today for Catalog IS-700

COLUMBIA ELECTRIC MFG. CO.
4543 HAMILTON AVENUE CLEVELAND 14, OHIO

Torrington Spherical Roller Bearings keep the mill train running on schedule

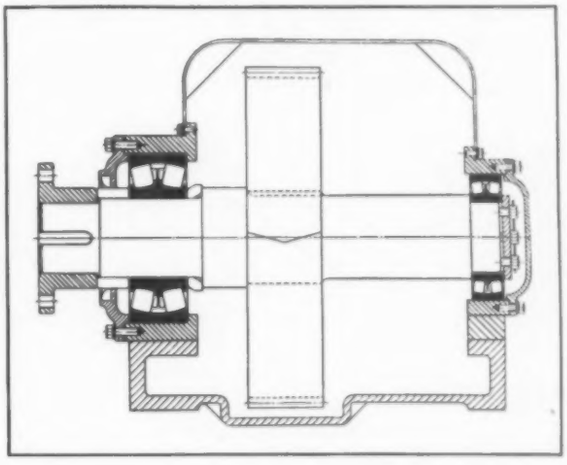


To keep strips of steel running down the mill train on schedule, every piece of equipment has to stay on the job. Heavy loads put severe strain on table rolls, gear drives, pinion stands, take-up reels, coilers, tension rolls, saws, shears and screwdowns. Shock loads can cause shafts to deflect, pinching and jamming rigid bearings and shutting down the train. Mill operators find the surest way to get sustained operation, with automatic alignment under deflection, is to use Torrington Spherical Roller Bearings.



◀ **In this table roll mounting,** bearings are positioned some distance apart. With rigid bearings, initial alignment is difficult to secure. This Spherical Roller Bearing design automatically assures proper initial alignment.

Or consider this gear drive. The length of the final reduction shaft makes it subject to deflection. When loads are heaviest and deflection greatest, Spherical Roller Bearings maintain the full area of bearing contact surface. ▶



Equip your heavy-duty mill machinery with reliable Torrington Spherical Roller Bearings for "on-schedule" production with minimum maintenance. Our engineers will be glad to help you with design and application. Write us today. THE TORRINGTON COMPANY, South Bend 21, Ind., or Torrington, Conn. District offices and distributors in principal cities of United States and Canada.

TORRINGTON SPHERICAL ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Straight Roller Needle • Ball • Needle Rollers

MAINTENANCE CUT

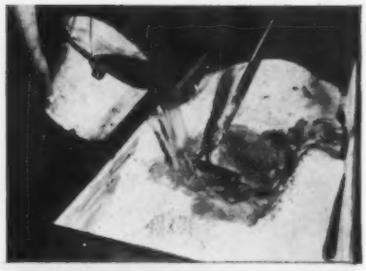
Several Thousand Dollars Per Year with **KAOCAST**

Photographs courtesy Ford Motor Company

A large automobile manufacturing firm found that high temperatures and severe operating conditions were playing havoc with the doors of their 15-ton electric furnaces. Run 16 hours a day, 5 days a week, these furnaces are poured every 2½ hours and are charged twice during each cycle. With a good grade of firebrick, furnace door linings lasted an average of only two or three days before replacements were necessary.

A trial installation of KAOCAST—the B&W high temperature Refractory Castable—was made. The KAOCAST doors stood up two to three weeks . . . *five to eight times longer than firebrick.* As a result, doors on all electric furnaces of this type are now lined with KAOCAST. *Savings in maintenance are running into thousands of dollars per year.*

Your B&W Refractories Engineer will be glad to show how KAOCAST will cut your furnace operating cost. Write or call him today.



KAOCAST, easy to use as ordinary concrete, can be mixed in mortar box or concrete mixer.

Shell of furnace door, cleaned, ready for installation of KAOCAST.

Shoveling KAOCAST into place. KAOCAST can also be poured like ordinary concrete, plastered in place, or applied with a cement gun.

B&W REFRACTORIES PRODUCTS

B&W 80 FIREBRICK • B&W JUNIOR FIREBRICK
B&W 80 GLASS TANK BLOCKS • B&W INSULATING FIREBRICK
B&W REFRACTORY CASTABLES, PLASTICS AND MORTARS

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Publication Service...

OCTOBER, 1949

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Opposed Impeller Pump

A copy of a new opposed impeller pump catalog is ready for you. The pumps described in this catalog are available in pressures to 1000 psi and they are particularly suitable for boiler feed, refinery, pipeline, mine drainage, water supply, descaling spray and general hydraulic service. The catalog contains a complete description of both two and four stage units, along with rating and dimension tables. (1550) DeLaval Steam Turbine Co.

(2) Large D-c Motors

Latest construction features of Allis-Chalmers large direct-current motors, used in many industries especially those having applications requiring wide speed variation and fine speed control, are discussed in a new 40-page bulletin just released. Included is a comprehensive description of "Frog-Leg" armature windings, a combination wave and lap winding that gives good commutation without cross-connectors, and views of the new style mill-type spherical seated thrust bearing with welded-steel pedestal for heavy service. Controls for the motors are also covered in the bulletin. (05B6002-A). Allis-Chalmers Mfg. Co.

(3) Auto-Floor Manipulators

A new catalog section describing varied types of auto-floor manipulators has just been issued. This latest section, complete with four complete detail drawings of auto-floor manipulators, compiles valuable information on capacities, maneuverability and purchasing requirements for these trackless manipulators. The section outlines the details of auto-floor manipulators ranging in capacities from 2000 to 20,000 lb. Previously announced sections dealing with Brosius clay guns and goggle and bellows valves are also available. Edgar E. Brosius Co., Inc.

(4) Variable Speed Control

A new bulletin completely describing the improved design of Reeves Vari-Speed Jr. unit for light horsepower requirements is available. Bulletin includes description, photographs, rating and dimension tables, and prices. Unit delivers infinitely variable speed to any driven machine with speed ratios from 1¾ to 2¾:1, and is made in six sizes for use with any standard constant speed motor up to 1½ hp. (VN-4912). Reeves Pulley Co.

(5) Abrasive Resistant Material

A new bulletin, "How to Reduce Abrasive Wear with Thermalloy HC-250," has just been released. This bulletin describes the physical properties of "Thermalloy HC-250," listing the many uses and advantages of this exceptionally abrasive resistant material. Physical properties are compared with 13 per cent manganese steel, ABK Metal (controlled Ni-Hard) and white cast iron, in a carefully compiled table. The bulletin describes case histories of the metal giving actual field service data in each case. Information is also included on machining and high temperature service. Electro-Alloys division of American Brake Shoe Co.

(6) Pre-Lubricated Bearings

A new booklet presents facts about the pre-lubricated bearings used in "Life-Line" motors. Starting with a discussion of why pre-lubricated bearings are possible, the booklet includes sections devoted to "Desirable Qualities of Grease," "Tests to Prove the Adequacy of Grease," and "Tests to Prove the Seal's Effectiveness." Several case-history-type examples are included. (B-4378). Westinghouse Electric Corp.

(7) Automatic Lubrication

A bulletin is available describing an entirely new method of providing automatic plug valve-lubrication through the use of a new energizable lubricant. The lubricant draws its energy from the pressure used in injecting it into the valve. This stored energy, when released, acts to move the lubricant through interior valve channels into any void that might occur. Man-hours spent in the maintenance of pressurized plug valves are expected to be drastically cut through the use of the new lubricant. The bulletin states that the lubricant will materially reduce the frequency of re-lubrications of plug valves. By maintaining such valves in fully lubricated condition the life of the valves is expected to increase. Many additional features and advantages of this new lubricant, called Hypermatic, are contained in a bulletin now ready. Information and data on the different types are included, as well as a cross reference table for changeover from the old lubricant to Hypermatic. Nordstrom Valve division, Rockwell Manufacturing Co.

(8) Metal Surface Preparation

Just issued is a special descriptive folder on the Oakite "CrysCoat" process, a metal surface-preparation procedure designed primarily for application in pressure-spray washing machines. The folder tells how this process effects improved adhesion of paint to metal, prevents corrosion of parts before painting, and localizes underpaint corrosion when final finishes are scratched or damaged. The method is said to save paint, produce more lustrous finishes, and prolong service life of painted products.

"CrysCoating" solutions, the folder concludes, are easy to prepare, easy to control, and have long working life. They are effective on steel, cast iron, aluminum sheet and aluminum castings when

applied in pressure-spray washing machines, and on zinc die castings and galvanized surfaces by tank application. Oakite Products, Inc.

(9) Lifting Magnet Controller

A lifting magnet controller catalog has just been issued describing new automatic-discharge controllers for all sizes, types and makes of lifting magnets. Manual-discharge type of controllers for small magnets also illustrated and detailed. (905). Electrical Controller and Manufacturing Co.

(10) Electronic Catalog

Publication of a 196-page catalog is announced, covering "Everything in Radio and Electronics." Special emphasis has been placed on equipment for industrial maintenance, research and production requirements. There are detailed listings of standard and special-application electronic tubes, test instruments, voltage stabilizers, transformers, resistors, condensers, rheostats, relays, switches, rectifiers, tools, wire and cable, batteries, sockets, generators, power supplies and other types of equipment in the industrial field. Allied Radio Corp.

(11) Preventive Maintenance Control

Preventive maintenance of machines and equipment and the record control system needed to administer such a program effectively, is the subject of a report just issued. Systems described and illustrated in this six page report are being used effectively by many manufacturers to prevent interruption of production schedules; to increase operating efficiency, to prevent breakdowns in delivery promises; and to reduce cost of manufacture. The system is based on a procedure which prompts scientific inspection of machines, so as to curtail "emergency" repairs and facilitate discovery of that point in the performance of any machine where the law of diminishing returns sets in.

This folder also outlines how preventive maintenance records may be combined with property records to insure that exactly the right amount of equipment is on hand at all times, maintained in top operating condition. A section is also devoted to inventory systems used to control stocks of replacement parts and operating supplies. (KD-449) Systems and Methods Research division, Remington-Rand, Inc.

(12) Bonded Refractories

A four page illustrated bulletin is available which traces the development and discusses the properties and applications of Taylor Sillimanite (Tasil) special refractories. These are aluminum silicate refractories in which the alumina and silica are combined as mullite ($3Al_2O_3 . 2SiO_2$). Tasil refractories are supplied as standard bricks, special shapes, cements, castables, ramming mixes and patching compounds to the glass, metallurgical, ceramic and chemical process industries. (312). Charles Taylor Sons Co.

(13) Rotary Positive Blower

A bulletin is available covering the smaller size Type AF rotary positive blowers, for pressure or suction service. These blowers are built in 18 standard sizes, with capacities ranging from 5 to 700 cfm up to 3 lb, 5 to 415 cfm up to 5 lb, and 15 to 245 cfm up to 7 lb, thus offering an extremely wide selection in available stock sizes. This bulletin covers the construction features and operating advantages of rotary positive blowers. All the different driving arrangements are illustrated, which include single pulley, multiple V-belt, direct-coupled, and integrally mounted motorized variable speed driving unit. A selection table, covering the capacity and pressure range of each blower size, is included in the bulletin, together with a dimension print that gives complete details on all standard sizes. (21-B-37). Roots-Connersville Blower Corp.

(14) Fire Brick

A new bulletin featuring "Mullitex," super duty fire brick and "Mullitex RB," special super duty refractory, has just been released. Properties, typical applications and detailed information on these and many other refractory materials are included in a convenient, reference table. Walsh Refractories Corp.

(15) Condensate Drainage Control

A new 24-page publication on the "Cochrane C-B System of Condensate Drainage Control comprises 6 pages of a technical discussion of this unique system of high pressure, high temperature condensate return, followed by specifications of the two types of C-B unit, after which are detailed fifty-seven case histories and testimonials including photographs, flow diagrams and details of installation, all representing savings in fuel, increased production, more uniform quality and reduction in maintenance and repair costs. A survey form included has provision for sketch as well as details of c ondensate removal problem. (3250). Cochrane Corp.

(16) Electrical Controls

Cutler-Hammer has published the 1949-1950 edition of its merchandising catalog. Illustrated and described are the company's line of safety switches, service control and multi-breakers, motor control and electrical specialties. Cutler-Hammer, Inc.

(17) Combustion Control

A folder is available describing the Morgan-Isley system of combustion control which is a radical change from the natural draft system of supplying combustion air and exhausting the waste products of combustion. This control does the job mechanically. It may be regulated to maintain the most efficient operating conditions. It allows the installation of additional checker capacity which returns more heat and increases production because it produces faster heating. The system is relatively inexpensive and the foundations are relatively light compared to a natural draft system. The bulletin shows a large sectional view in color illustrating the control installed on a typical regenerative furnace. Included is a description of the Morgan air ejector which is an improved, economical method of exhausting gases from furnaces and boilers — also, for discharging acid or other fumes. Morgan Construction Co.

(18) Single Phase Motor

Literature is available describing a new single phase motor with standard speeds of 3600, 1800 and 1200 rpm. Slower speeds for these motors can be supplied on request. The literature includes a description of the operation of these single phase motors with typical performnace tables and curves. Connec-

tion diagrams are shown. (722). The Louis Allis Co.

(19) Hydraulic Weighing Cells

A new 8-page bulletin describes and profusely illustrates Emery hydraulic cells for general industrial weighing and special laboratory testing equipment. Six standard models ranging in capacity from 10,000 to 100,000 lb, and special cells having load capacities from 40 lb to 2500 tons are described. The bulletin also describes three self-contained, portable weighing units or scales with Bourdon tube indicators and several cell applications with the still more accurate Tate-Emery indicator. It includes illustrated descriptions of the principles of the Emery cell and Tate-Emery indicator. (288). Baldwin Locomotive Works.

(20) Centrifugal Pump Handbook

Now being released is a revised handbook on the care of all makes of centrifugal pumps. The 16-page bulletin gives the how and why of pump construction and their effect on pump maintenance. The booklet tells how to figure head; it carries tables to help determine total friction loss. Causes and cures for various sources of troubles are offered along with a new maintenance timetable. Other subjects covered in the bulletin include little known facts about cavitation and how to protect pumps against it; water's role as a lubricant in pumps, and common mistakes in packing stuffing boxes. (08X6256A). Allis-Chalmers Mfg. Co.

(21) Motor Protection

"The Inside Story of Allis-Chalmers 'Safety-Circle' Motor Protection," is a new 8-page bulletin just released. The bulletin describes the design and construction features of the "Safety-Circle" motor which add up to long life and low operating costs. These include a heavy cast iron frame which completely surrounds all working parts, a double insulated stator, a die-cast rotor, efficient ventilation, drip-proof end brackets, pre-lubricated bearings, precision machined feet, and roomy conduit box. According to the bulletin, "Safety-Circle" drip-proof and splash-proof motors are available in sizes from one horsepower at 1800 rpm to 20 horsepower at 3600 rpm, in frames 326 and smaller. All dimensions are NEMA standards. The advantages of "Safety-Circle" design and complete protection are also available in totally-enclosed non-ventilated, totally-enclosed fan-cooled, and explosion-proof types of motors, it is pointed out. (51B6210B). Allis-Chalmers Mfg. Co.

(22) Electrostatic Sampler

The new MSA electrostatic sampler for quantitative sampling of airborne dusts, fumes, and smokes, is illustrated and completely described in a 4-page bulletin. Designed for high efficiency atmospheric sampling for all types of particulates in the ceramic, electrical, steel, and chemical processing industries, the MSA electrostatic sampler has been accepted by many safety and industrial hygiene agencies of the federal, state, and local governments. The electrostatic sampler is equipped with a portable sampling head for easy sampling of the atmosphere at various levels. A special high voltage cable facilitates coiling and permits the use of an extension cable. A retractable stand provides support for the sampling head when remote operation is unnecessary. The sampler is equipped with a specially designed power pack, capable of producing 10,000 to 15,000 volts d-c, and an accurate high voltage indicator. The electrostatic sampler, together with a complete sampling tube kit is furnished in a convenient portable case. (CT-9). Mine Safety Appliances Co.

(23) Air Space Heater

Publication is announced of a new 12-page bulletin (No. 523) describing the Dravo "Counterflo" forced air space heater. Available in standard output capacities from 400,000 to 2,000,000 Btu's per hour, the warm air heater is direct fired either by oil or gas and can be supplied with combination burners for quick conversion from one fuel to the other. The new bulletin emphasizes the heater's "five-function" versatility. In addition to its primary use for comfort heating, it also can provide year 'round ventilating, process drying, tempering makeup air and heat curing. Long service life is assured by the heater's stainless steel combustion chamber. High efficiency (80 to 85 per cent) is achieved by four-pass counterflow combustion combined with a warm air recirculation principle. It is described as being especially suitable and economical for heating large structures without ductwork, but also may be employed as a central heating plant. Only electric power line, fuel piping and vent stack are needed to install the heater. (523). Dravo Corp.

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	AIR REDUCTION SALES CO.	CATALOG 5	This new Airco Regulator catalog gives authentic, understandable information on the function and operating characteristics of regulators.
51	AMERICAN MANGANESE STEEL DIVISION, AMERICAN BRAKE SHOE CO.	BULLETIN 1047-W	Bulletin describing hard surfacing by fusion welding.
52	ASKANIA REGULATOR CO.	BULLETIN 139 J	Bulletin giving details of the Askania jet pipe control principle.
53	AUTOMATIC TRANSPORTATION CO.		Catalog describing Automatic electric trucks for handling steel and allied products.
54	BAILEY METER CO.	BULLETIN 17	Tells how Bailey controls can save you money and speed up control installations.
55	BROWNING AND CO., VICTOR R.	BULLETIN "S"	Describes Browning mill type cranes.
56	CLEVELAND WORM AND GEAR CO.	CATALOG 300	Full description of "Speedaire," a new fan-cooled worm-gear speed reducer.
57	COLUMBIA ELECTRIC MANUFACTURING CO.	CATALOG IS-700	Describes motor generators for electroplating and electro-cleaning.
58	CRANE CO.	FOLDER AD-1761	Folder describing Crane iron body diaphragm valves.
59	CROUSE-HINDS CO.		The complete Obround series together with 15,000 other items for the electrician is listed in this condulet catalog.
60	CUTLER-HAMMER, INC.	BULLETIN 14010	Bulletin describes in detail Cutler-Hammer inductive time limit control.
61	DE LAVAL STEAM TURBINE CO.	CATALOG 50-14-R	Gives full description on De Laval worm gear speed reducers.
62	DOWELL, INC.		A new book containing detailed information on the uses and installation of Dowell magnesium anodes.
63	ELECTRIC CONTROLLER & MANUFACTURING CO.	BULLETIN 1190	Describes in detail short-throw, narrow width master switches.
64	ELECTRIC CONTROLLER & MANUFACTURING CO.	BULLETIN 942	Gives complete details on the "Tab-Weld Plate Resistors."
65	ELECTRIC SERVICE MANUFACTURING CO.		Detailed information on the full line of Keystone insulators, rail shoes, and current collectors is described in the catalog, "Keystone Industrial Products."
66	GENERAL ELECTRIC CO.	BULLETIN GEA-4469	Bulletin giving details on how better-cooled, better-protected d-c motors can help cut costs in your mill.
67	HAGAN CORP.	BULLETIN 2M48	Full description of the Hagan ring balance meter.
68	HOMESTEAD VALVE MANUFACTURING CO.	CATALOG 39—SECTION 5	Shows sizes, types and pressure ratings for Homestead-Reiser lubricated plug valves.
69	HUNT AND SON, INC., C. B.		Catalog giving full details about the complete line of Quick-As-Wink lever operated hydraulic valves.
70	JOHNS-MANVILLE CORP.	CATALOG PK-35A	Contains information on the Goetze-V-Tite Gaskets for ring-type joint flanges.
71	LINK-BELT CO.	BOOK NO. 2345	Description of the Link-Belt car shaker, which is especially valuable for unloading damp or frozen materials.
72	MAGOR CAR CORP.		A new Magor air dump car brochure is available showing how these modern steel plant cars can save you money.
73	NEW YORK & NEW JERSEY LUBRICANT CO.	BULLETIN 504 IS	Catalog describes how motors run cooler and stoppages are reduced to an absolute minimum.
74	PENNSYLVANIA TRANSFORMER CO.	BOOKLET 1492	Information available on standard parts power transformers.
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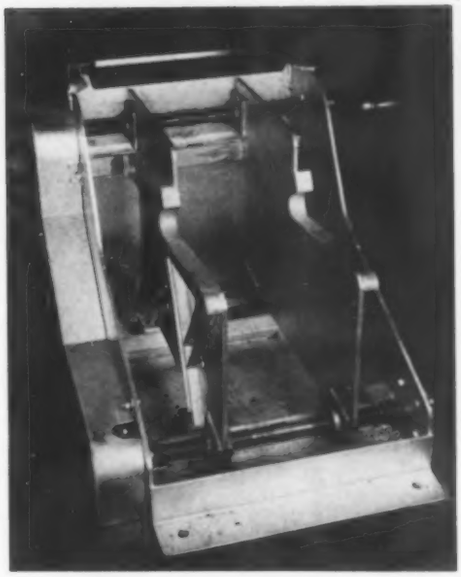

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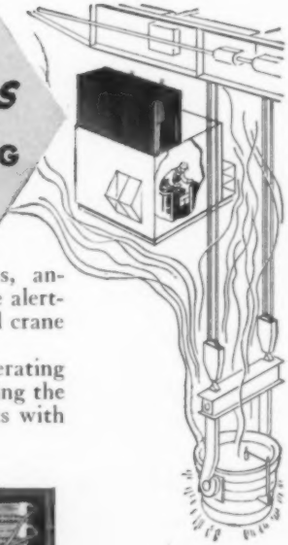

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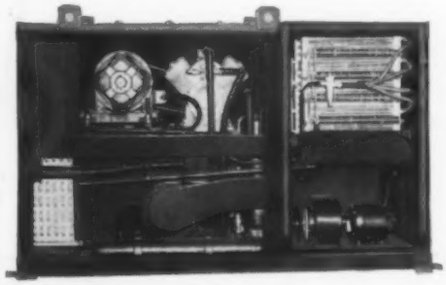

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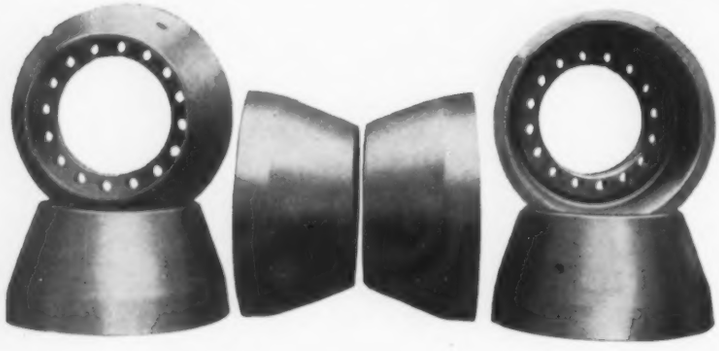

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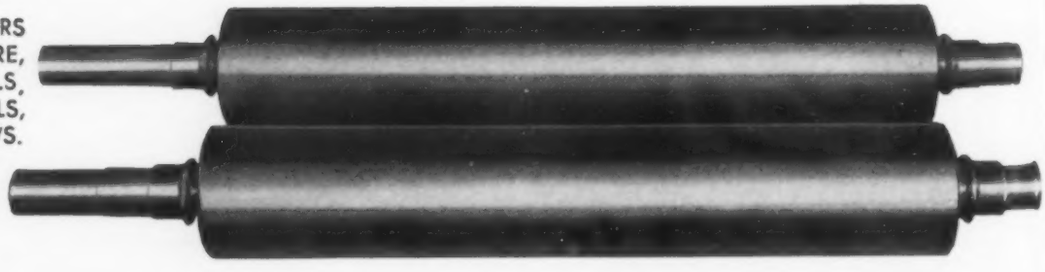

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Book Reviews

▲ Welding and Cutting Manual, published by Linde Air Products Co., 30 E. 42nd Street, New York, N. Y. 208 pages, 6 x 9 in. $1.80.

This new handbook on the oxy-acetylene process should be useful as a reference and instruction book for anyone who does welding and cutting. The style is simple and easy to read and instructions are given in step-by-step photographs of actual repair jobs. The book gives short-cuts and instructions for bronze-welding; fusion welding; soldering; hard-facing; cutting steel and cast iron; heating, forming, and straightening metals; welding and cutting pipe; and welding non-ferrous metals. The appendix contains useful charts and tables, a complete glossary welding terms, and a list of 100 repair jobs with recommended welding methods.

▲ "Handbook of Steel and Steel Products" has been published by The British Standards Institution, 28 Victoria St., London, S.W. 1. (B.S. Handbook No. 10) 674 pp. 8½ in. by 5½ in. Stiff cloth, price: £1 5s. Od. Date of publication: June 15th, 1949.

The intention of this handbook has been to present a comprehensive picture of the whole field of British steel products, and to give in summarized form all the standards that apply to them. Its compilation has been a co-operative effort of the whole of the British Steel Industry, acting through an editorial committee under the chairmanship of Mr. Sinclair Kerr of the Lancashire Steel Corp. and Mr. T. Jolly of Guest, Keen & Baldwin's Ltd. There are three main parts to the book, and an index. The parts are: articles describing the manufacture of steel and of steel products, classified summaries of the essential technical requirements of British standards for steel and steel products, and other information of general interest, e.g., methods of test, heat treatment definitions and conversion factors.

The handbook is fully indexed, and is expected to be exceptionally useful to all buyers and users of British steel.

▲ A new edition of the American Standard Letter Symbols for Gear Engineering for use in those mathematical equations and formulas that deal with toothed gearing has just been completed. Prepared by the Sectional Committee on Standardization of Gears, B6, sponsored by the American Gear Manufacturers Association and the American Society of Mechanical Engineers, the standard closely follows the general principles laid down by the Sectional Committee on Letter Symbols and Abbreviations for Science and Engineering, Z10.

The American Standard Letter Symbols for Gear Engineering, B6.5-1949, can be obtained from the American Society of Mechanical Engineers, the sponsor organization that published it, or from the American Standards Association. Copies are 30 cents each.

▲ The belief that differences in the yield of ammonia at various chemical-recovery coking plants are due to inherent differences in the coals used as well as to different operating conditions is supported by a report released today by James Boyd, Director of the Bureau of Mines.

The report gives the ammonia yields from 58 coals carbonized by the Bureau of Mines–American Gas Association method. Coals tested were of high-volatile A, medium-volatile and low-volatile bituminous rank. They came from Alabama, Kentucky, Oklahoma, Pennsylvania, Utah, Virginia, Washington, and West Virginia.

High-volatile A coals from Washington, Alabama, and Utah gave high ammonia yields, Oklahoma and Kentucky coals yielded average amounts, the report shows the yields from Pennsylvania and West Virginia coals were lower than average, and differences in medium- and low-volatile coals were similar. It concludes that "the differences in yields from coals representing various sections of this country are due in part to inherent differences in the coals carbonized." However, it observes that a definite explanation of the differences will have to await more knowledge of the constitution of coal.

A free copy of Report of Investigations 4526, "Coal Carbonization: Ammonium Sulfate Yields from Coals of Various Regions of the United States," by D. A. Reynolds and D. E. Wolfson, Bureau chemists, can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

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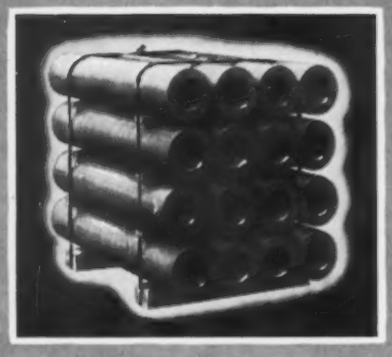

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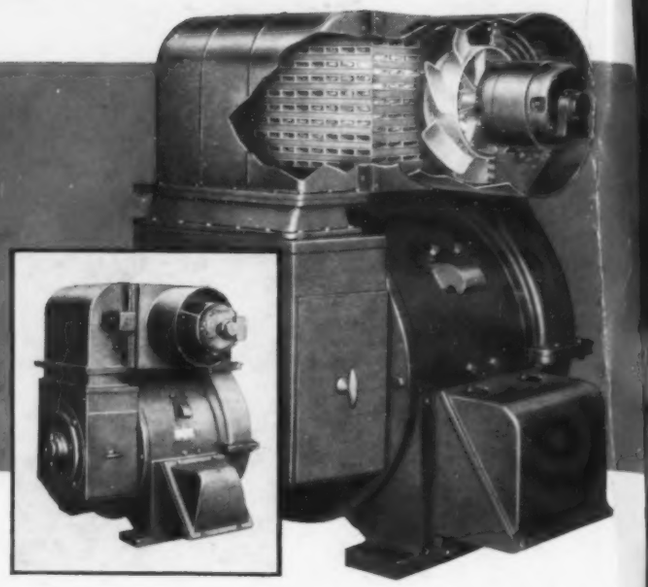

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